PB84-244433

Development Document for Effluent Limitations Guidelines and Standards for the Aluminum Forming Point Source Category. Volume 2

(U.S.) Environmental Protection Agency
Washington, DC

Jun 84

U.S. Department of Commerce
National Technical Information Service
NTIS

United States
Environmental Protection
Agency

Effluent Guidelines Division
WH-552
Washington DC 20460

EPA 440/1-84/073
June 1984

PB84-244433

Water

EPA

Development Document for Effluent Limitations Guidelines and Standards for the

Final

Aluminum Forming

Point Source Category

Volume II

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA 440/1-84/073	2.	3. RECIPIENT'S ACCESSION NO. PB84 244433
4. TITLE AND SUBTITLE Final Development Document for Effluent Limitations Guidelines and Standards for the Aluminum Forming Point Source Category: Volume 2		5. REPORT DATE June 1984 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Janet K. Goodwin, Project Officer		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Environmental Protection AGency Office of Water 401 M. Street S.W. Washington, D.C. 20460		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Same As Above		13. TYPE OF REPORT AND PERIOD COVERED Final 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This document provides tha data and rationale used to develop the effluent limitations and standards for the Aluminum Forming point source category.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
aluminum forming wastewater treatment	BPT BAT PSES PSNS NSPS	

18. DISTRIBUTION STATEMENT unlimited	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES 594
	20. SECURITY CLASS *(This page)*	22. PRICE

EPA Form 2220-1 (9-73)

DEVELOPMENT DOCUMENT
for
EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS
for the
ALUMINUM FORMING POINT SOURCE CATEGORY

(VOLUME II)

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SECTION VII

CONTROL AND TREATMENT TECHNOLOGY

This section describes the treatment techniques currently used or available to remove or recover wastewater pollutants normally generated by the aluminum forming industrial point source category. Included are discussions of individual end-of-pipe treatment technologies and in-plant technologies. These treatment technologies are widely used in many industrial categories and data and information to support their effectiveness has been drawn from a similarly wide range of sources and data bases.

END-OF-PIPE TREATMENT TECHNOLOGIES

Individual recovery and treatment technologies are described which are used or are suitable for use in treating wastewater discharges from aluminum forming facilities. Each description includes a functional description and discussions of application and performance, advantages and limitations, operational factors (reliability, maintainability, solid waste aspects), and demonstration status. The treatment processes described include both technologies presently demonstrated within the aluminum forming category, and technologies demonstrated in treatment of similar wastes in other industries.

Aluminum forming wastewater streams characteristically may be acid or alkaline; may contain substantial levels of dissolved or particulate metals including cadmium, chromium, copper, cyanide, lead, nickel, selenium, zinc, and aluminum; contain substantial amounts of toxic organics; and are generally free from strong chelating agents. These toxic inorganic pollutants, along with the nonconventional pollutant aluminum, constitute the most significant wastewater pollutants in this category.

In general, these pollutants are removed by oil removal (skimming, emulsion breaking, and flotation), chemical precipitation and sedimentation, or filtration. Most of them may be effectively removed by precipitation of metal hydroxides or carbonates utilizing the reaction with lime, sodium hydroxide, or sodium carbonate. For some, improved removals are provided by the use of sodium sulfide or ferrous sulfide to precipitate the pollutants as sulfide compounds with very low solubilities.

Discussion of end-of-pipe treatment technologies is divided into three parts: the major technologies; the effectiveness of major technologies; and minor end-of-pipe technologies. technology.

MAJOR TECHNOLOGIES

In Sections IX, X, XI, and XII, the rationale for selecting treatment systems is discussed. The individual technologies used in the system are described here. The major end-of-pipe technologies for treating aluminum forming wastewaters are: chemical reduction of hexavalent chromium, chemical precipitation of dissolved metals, cyanide precipitation, granular bed filtration, pressure filtration, settling of suspended solids, skimming of oil, chemical emulsion breaking, and thermal emulsion breaking. In practice, precipitation of metals and settling of the resulting precipitates is often a unified two-step operation. Suspended solids originally present in raw wastewaters are not appreciably affected by the precipitation operation and are removed with the precipitated metals in the settling operations. Settling operations can be evaluated independently of hydroxide or other chemical precipitation operations, but hydroxide and other chemical precipitation operations can only be evaluated in combination with a solids removal operation.

1. Chemical Reduction of Chromium

Description of the Process. Reduction is a chemical reaction in which electrons are transferred to the chemical being reduced from the chemical initiating the transfer (the reducing agent). Sulfur dioxide, sodium bisulfite, sodium metabisulfite, and ferrous sulfate form strong reducing agents in aqueous solution and are often used in industrial waste treatment facilities for the reduction of hexavalent chromium to the trivalent form. The reduction allows removal of chromium from solution in conjunction with other metallic salts by alkaline precipitation. Hexavalent chromium is not precipitated as the hydroxide.

Gaseous sulfur dioxide is a widely used reducing agent and provides a good example of the chemical reduction process. Reduction using other reagents is chemically similar. The reactions involved may be illustrated as follows:

$$3SO_2 + 3H_2O \longrightarrow 3H_2SO_3$$
$$3H_2SO_3 + 2H_2CrO_4 \longrightarrow Cr_2(SO_4)_3 + 5H_2O$$

The above reactions are favored by low pH. A pH of from 2 to 3 is normal for situations requiring complete reduction. At pH levels above 5, the reduction rate is slow. Oxidizing agents such as dissolved oxygen and ferric iron interfere with the reduction process by consuming the reducing agent.

A typical treatment consists of 45 minutes retention in a reaction tank. The reaction tank has an electronic recorder-controller device to control process conditions with respect to pH and oxidation-reduction potential (ORP). Gaseous sulfur dioxide is metered to the reaction tank to maintain the ORP within the range of 250 to 300 millivolts. Sulfuric acid is added to maintain a pH level of from 1.8 to 2.0. The reaction tank is equipped with a propeller agitator designed to provide approximately one turnover per minute. Figure VII-1 shows a continuous chromium reduction system.

Application and Performance. Chromium reduction is used in aluminum forming for treating rinses of chromic acid etching solutions used for high-magnesium aluminum. Cooling tower blowdown may also contain chromium as a biocide in waste streams. Coil coating operations, frequently found on-site with aluminum forming operations, are sometimes a source of chromium-bearing wastewaters. A study of an operational waste treatment facility chemically reducing hexavalent chromium has shown that a 99.7 percent reduction efficiency is easily achieved. Final concentrations of 0.05 mg/l are readily attainable, and concentrations of 0.01 mg/l are considered to be attainable by properly maintained and operated equipment.

Advantages and Limitations. The major advantage of chemical reduction to reduce hexavalent chromium is that it is a fully proven technology based on many years of experience. Operation at ambient conditions results in low energy consumption, and the process, especially when using sulfur dioxide, is well suited to automatic control. Furthermore, the equipment is readily obtainable from many suppliers, and operation is straightforward.

One limitation of chemical reduction of hexavalent chromium is that for high concentrations of chromium, the cost of treatment chemicals may be prohibitive. When this situation occurs, other treatment techniques are likely to be more economical. Chemical interference by oxidizing agents is possible in the treatment of mixed wastes, and the treatment itself may introduce pollutants if not properly controlled. Storage and handling of sulfur dioxide is somewhat hazardous.

Operational Factors. Reliability: Maintenance consists of periodic removal of sludge, the frequency of removal depends on the input concentrations of detrimental constituents.

Solid Waste Aspects: Pretreatment to eliminate substances which will interfere with the process may often be necessary. This process produces trivalent chromium which can be controlled by further treatment. However, small amounts of sludge may be collected as the result of minor shifts in the solubility of the contaminants. This sludge can be processed by the main sludge treatment equipment.

Demonstration Status. The reduction of chromium waste by sulfur dioxide or sodium bisulfite is a classic process and is used by numerous plants which have hexavalent chromium compounds in wastewaters from operations such as electroplating and coil coating. At least two aluminum forming plants use chromium reduction to treat wastewater and therefore this technology is demonstrated in this category.

2. Chemical Precipitation

Dissolved toxic metal ions and certain anions may be chemically precipitated for removal by physical means such as sedimentation, filtration, or centrifugation. Several reagents are commonly used to effect this precipitation:

1) Alkaline compounds such as lime or sodium hydroxide may be used to precipitate many toxic metal ions as metal hydroxides. Lime also may precipitate phosphates as insoluble calcium phosphate and fluorides as calcium fluoride.

2) Both "soluble" sulfides such as hydrogen sulfide or sodium sulfide and "insoluble" sulfides such as ferrous sulfide may be used to precipitate many heavy metal ions as insoluble metal sulfides.

3) Ferrous sulfate, zinc sulfate, or both (as is required) may be used to precipitate cyanide as a ferro or zinc ferricyanide complex.

4) Carbonate precipitates may be used to remove metals either by direct precipitation using a carbonate reagent such as calcium carbonate or by converting hydroxides into carbonates using carbon dioxide.

These treatment chemicals may be added to a flash mixer or rapid mix tank, to a presettling tank, or directly to a clarifier or other settling device. Because metal hydroxides tend to be colloidal in nature, coagulating agents may also be added to facilitate settling. After the solids have been removed, final pH adjustment may be required to reduce the high pH created by the alkaline treatment chemicals.

Chemical precipitation as a mechanism for removing metals from wastewater is a complex process of at least two steps - precipitation of the unwanted metals and removal of the precipitate. Some very small amount of metal will remain dissolved in the wastewater after complete precipitation. The amount of residual dissolved metal depends on the treatment chemicals used and related factors. The effectiveness of this method of removing any specific metal depends on the fraction of the specific metal in the raw waste (and hence in the precipitate) and the effectiveness of suspended solids removal. In specific instances, a sacrificial ion such as iron or aluminum may be added to aid in the removal of toxic metals by co-precipitation process and reduce the fraction of a specific metal in the precipitate.

Application and Performance. Chemical precipitation is used in aluminum forming for precipitation of dissolved metals. It can be used to remove metal ions such as aluminum, antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, tin, and zinc. The process is also applicable to any substance that can be transformed into an insoluble form such as fluorides, phosphates, soaps, sulfides, and others. Because it is simple and effective, chemical precipitation is extensively used for industrial waste treatment.

The performance of chemical precipitation depends on several variables. The most important factors affecting precipitation effectiveness are:

1. Maintenance of an appropriate (usually alkaline) pH throughout the precipitation reaction and subsequent settling;
2. Addition of a sufficient excess of treatment ions to drive the precipitation reaction to completion;
3. Addition of an adequate supply of sacrificial ions (such as iron or aluminum) to ensure precipitation and removal of specific target ions; and
4. Effective removal of precipitated solids (see appropriate technologies discussed under "Solids Removal").

Control of pH. Irrespective of the solids removal technology employed, proper control of pH is absolutely essential for favorable performance of precipitation-sedimentation technologies. This is clearly illustrated by solubility curves for selected metals hydroxides and sulfides shown in Figure VII-2, and by plotting effluent zinc concentrations against pH as shown in Figure VII-3. Figure VII-3 was obtained from Development Document for the Proposed Effluent Limitations Guidelines and New Source Performance Standards for the Zinc Segment of Nonferrous Metals Manufacturing Point Source Category, U.S. E.P.A., EPA 440/1-74/033, November, 1974. Figure VII-3 was plotted from the sampling data from several facilities with metal finishing operations. It is partially illustrated by data obtained from three consecutive days of sampling at one metal processing plant

(47432) as displayed in Table VII-1. Flow through this system is approximately 49,263 l/hr (13,000 gal/hr).

This treatment system uses lime precipitation (pH adjustment) followed by coagulant addition and sedimentation. Samples were taken before (in) and after (out) the treatment system. The best treatment for removal of copper and zinc was achieved on day one, when the pH was maintained at a satisfactory level. The poorest treatment was found on the second day, when the pH slipped to an unacceptably low level and intermediate values were achieved on the third day, when pH values were less than desirable but in between the values of the first and second days.

Sodium hydroxide is used by one facility (plant 439) for pH adjustment and chemical precipitation, followed by settling (sedimentation and a polishing lagoon) of precipitated solids. Samples were taken prior to caustic addition and following the polishing lagoon. Flow through the system is approximately 22,700 l/hr (6,000 gal/hr). Metals removal data for this system are presented in Table VII-2.

These data indicate that the system operated efficiently. Effluent pH was controlled within the range of 8.6 to 9.3, and while raw waste loadings were not unusually high, most toxic metals were removed to very low concentrations.

Lime and sodium hydroxide (combined) are sometimes used to precipitate metals. Data developed from plant 40063, a facility with a metal-bearing wastewater, exemplify efficient operation of a chemical precipitation and settling system. Table VII-3 shows sampling data from this system, which uses lime and sodium hydroxide for pH adjustment, chemical precipitation, polyelectrolyte flocculant addition, and sedimentation. Samples were taken of the raw waste influent to the system and of the clarifier effluent. Flow through the system is approximately 19,000 l/hr (5,000 gal/hr).

At this plant, effluent TSS levels were below 15 mg/l on each day, despite average raw waste TSS concentrations of over 3,500 mg/l. Effluent pH was maintained at approximately 8, lime addition was sufficient to precipitate the dissolved metal ions, and the flocculant addition and clarifier retention served to remove effectively the precipitated solids.

Sulfide precipitation is sometimes used to precipitate metals resulting in improved metals removals. Most metal sulfides are less soluble than hydroxides and the precipitates are frequently more dependably removed from water. Solubilities for selected metal hydroxide, carbonate, and sulfide precipitates are shown in Table VII-4 (Source: Lange's Handbook of Chemistry). Sulfide precipitation is particularly effective in removing specific metals such as silver and mercury. Sampling data from three industrial plants using sulfide precipitation appear in Table VII-5. The data were obtained from three sources:

1. *Summary Report, Control and Treatment Technology for the Metal Finishing Industry: Sulfide Precipitation*, USEPA, EPA No. 625/8/80-003, 1979.
2. *Industry Finishing*, Vol. 35, No. 11, November, 1979.
3. Electroplating sampling data from plant 27045.

In all cases except iron, effluent concentrations are below 0.1 mg/l and in many cases below 0.01 mg/l for the three plants studied.

Sampling data from several chlorine-caustic manufacturing plants using sulfide precipitation demonstrate effluent mercury concentrations varying between 0.009 and 0.03 mg/l. As shown in Figure VII-2, the solubilities of PbS and Ag_2S are lower at alkaline pH levels than either the corresponding hydroxides or other sulfide compounds. This implies that removal performance for lead and silver sulfides should be comparable to or better than that for the heavy metal hydroxides. Bench-scale tests on several types of metal finishing and manufacturing wastewater indicate that metals removal to levels of less than 0.05 mg/l and in some cases less than 0.01 mg/l are common in systems using sulfide precipitation followed by clarification. Some of the bench-scale data, particularly in the case of lead, do not support such low effluent concentrations. However, lead is consistently removed to very low levels (less than 0.02 mg/l) in systems using hydroxide and carbonate precipitation and sedimentation.

Of particular interest is the ability of sulfide to precipitate hexavalent chromium (Cr^{+6}) without prior reduction to the trivalent state as is required in the hydroxide process. When ferrous sulfide is used as the precipitant, iron and sulfide act as reducing agents for the hexavalent chromium according to the reaction:

$$CrO_3 + FeS + 3\ H_2O \text{ -----}\rightarrow Fe(OH)_3 + Cr(OH)_3 + S$$

The sludge produced in this reaction consists mainly of ferric hydroxides, chromic hydroxides, and various metallic sulfides. Some excess hydroxyl ions are generated in this process, possibly requiring a downward re-adjustment of pH.

Based on the available data, Table VII-6 shows the minimum reliably attainable effluent concentrations for sulfide precipitation-sedimentation systems. These values are used to calculate performance predictions of sulfide precipitation-sedimentation systems. Table VII-6 is based on two reports:

1. Summary Report, Control and Treatment Technology for the Metal Finishing Industry: Sulfide Precipitation, U.S. EPA, EPA No. 625/8/80-003, 1979.

2. Addendum to Development Document for Effluent Limitations Guidelines and New Source Performance Standards, Major Inorganic Products Segment of Inorganics Point Source Category, U.S. EPA, EPA Contract No. EPA 68-01-3281 (Task 7), June, 1978.

Carbonate precipitation is sometimes used to precipitate metals, especially where precipitated metals values are to be recovered. The solubility of most metal carbonates is intermediate between hydroxide and sulfide solubilities; in addition, carbonates form easily filtered precipitates.

Carbonate ions appear to be particularly useful in precipitating lead and antimony. Sodium carbonate has been observed being added at treatment to improve lead precipitation and removal in some industrial plants. The lead hydroxide and lead carbonate solubility curves displayed in Figure VII-4 ("Heavy Metals Removal," by Kenneth Lanovette, Chemical Engineering/Deskbook Issue, Oct. 17, 1977) explain this phenomenon.

Co-precipitation with Iron - The presence of substantial quantities of iron in metal-bearing wastewaters before treatment has been shown to improve the removal of toxic metals. In some cases this iron is an integral part of the industrial wastewater; in other cases iron is deliberately added as a preliminary or first step of treatment. The iron functions to improve toxic metal removal by three mechanisms: the iron co-precipitates with toxic metals forming a stable precipitate which desolubilizes the toxic metal; the iron improves the settleability of the precipitate; and the large amount of iron reduces the fraction of toxic metal in the precipitate. Incidental co-precipitation with iron has been practiced for many years when iron was a substantial constituent of raw wastewater, and intentionally when iron salts were added as a coagulant aid. Aluminum or mixed iron-aluminum salt also have been used. The addition of iron for co-precipitation to aid in toxic metals removal is considered a routine part of state-of-the-art lime and settle technology which should be implemented as required to achieve optimal removal of toxic metals.

Co-precipitation using large amounts of ferrous iron salts is known as ferrite co-precipitation because magnetic iron oxide or ferrite is formed. The addition of ferrous salts (sulfate) is followed by alkali precipitation and air oxidation. The resultant precipitate is easily removed by filtration and may be removed magnetically. Data illustrating the performance of ferrite co-precipitation is shown in Table VII-7. The data are from:

1. Sources and Treatment of Wastewater in the Nonferrous Metals Industry, U.S. EPA, EPA No. 600/2-80-074, 1980.

Advantages and Limitations. Chemical precipitation has proven to be an effective technique for removing many pollutants from industrial wastewater. It operates at ambient conditions and is well suited to automatic control. The use of chemical precipitation may be limited because of interference by chelating agents, because of possible chemical interference of mixed wastewaters and treatment chemicals, or because of the potentially hazardous situation involved with the storage and handling of those chemicals. Aluminum forming wastewaters do not normally contain chelating agents or complex pollutant matrix formations which would interfere with or limit the use of chemical precipitation. Lime is usually added as a slurry when used in hydroxide precipitation. The slurry must be kept well mixed and the addition lines periodically checked to prevent blocking, which may result from a buildup of solids. Also, hydroxide precipitation usually makes recovery of the precipitated metals difficult, because of the heterogeneous nature of most hydroxide sludges.

The major advantage of the sulfide precipitation process is that the extremely low solubility of most metal sulfides promotes very high metal removal efficiencies; the sulfide process also has the ability to remove chromates and dichromates without preliminary reduction of the chromium to its trivalent state. In addition, sulfide can precipitate metals complexed with most complexing agents. The process demands care, however, in maintaining the pH of the solution at approximately 10 in order to restrict the generation of toxic hydrogen sulfide gas. For this reason, ventilation of the treatment tanks may be a necessary precaution in most installations. The use of insoluble sulfides reduces the problem of hydrogen sulfide evolution. As with hydroxide precipitation, excess sulfide ion must be present to drive the precipitation reaction to completion. Since the sulfide ion itself is toxic, sulfide addition must be carefully controlled to maximize heavy metals precipitation with a minimum of excess sulfide to avoid the necessity of post treatment. At very high excess sulfide levels and high pH, soluble mercury-sulfide compounds may also be formed. Where excess sulfide is present, aeration of the effluent stream can aid in oxidizing residual sulfide to the less harmful sodium sulfate (Na_2SO_4). The cost of sulfide precipitants is high in comparison with hydroxide precipitants, and disposal of metallic sulfide sludges may pose problems. An essential element in effective sulfide precipitation is the removal of precipitated solids from the wastewater and proper disposal in an appropriate site. Sulfide precipitation will also generate a higher volume of sludge than hydroxide precipitation, resulting in higher disposal and dewatering costs. This is especially true when ferrous sulfide is used as the precipitant.

Sulfide precipitation may be used as a polishing treatment after hydroxide precipitation-sedimentation. This treatment configuration may provide the better treatment effectiveness of sulfide precipitation while minimizing the variability caused by changes in raw waste and reducing the amount of sulfide precipitant required.

Operational Factors. Reliability: Alkaline chemical precipitation is highly reliable, although proper monitoring and control are required. Sulfide precipitation systems provide similar reliability.

Maintainability: Major maintenance needs involve periodic upkeep of monitoring equipment, automatic feeding equipment, mixing equipment, and other hardware. Removal of accumulated sludge is necessary for efficient operation of precipitation-sedimentation systems.

Solid Waste Aspects: Solids which precipitate out are removed in a subsequent treatment step. Ultimately, these solids require proper disposal.

Demonstration Status. Chemical precipitation of metal hydroxides is a classic waste treatment technology used by most industrial waste treatment systems. Chemical precipitation of metals in the carbonate form alone has been found to be feasible and is commercially used to permit metals recovery and water reuse. Full scale commercial sulfide precipitation units are in operation at numerous installations. As noted earlier, sedimentation to remove precipitates is discussed separately.

3. Cyanide Precipitation

Cyanide precipitation, although a method for treating cyanide in wastewaters, does not destroy cyanide. The cyanide is retained in the sludge that is formed. Reports indicate that during exposure to sunlight the cyanide complexes can break down and form free cyanide. For this reason the sludge from this treatment method must be disposed of carefully.

Cyanide may be precipitated and settled out of wastewaters by the addition of zinc sulfate or ferrous sulfate. In the presence of iron, cyanide will form extremely stable cyanide complexes. The addition of zinc sulfate or ferrous sulfate forms zinc ferrocyanide or ferro and ferricyanide complexes.

Adequate removal of the precipitated cyanide requires that the pH must be kept at 9.0 and an appropriate detention time be maintained. A study has shown that the formation of the complex is very dependent on pH. At a pH of either 8 or 10, the residual cyanide concentrations measured is twice that of the same reaction carried out at a pH of 9. Removal efficiencies also depend heavily on the retention time allowed. The formation of the complexes takes place rather slowly. Depending upon the excess amount of zinc sulfate or ferrous sulfate added, at least a 30-minute retention time should be allowed for the formation of the cyanide complex before continuing on to the clarification stage.

One experiment with an initial concentration of 10 mg/l of cyanide showed that 98 percent of the cyanide was complexed 10 minutes after the addition of ferrous sulfate at twice the theoretical amount necessary. Interference from other metal ions, such as cadmium, might result in the need for longer retention times.

Table VII-8 presents data from three coil coating plants. Plant 1057 also does aluminum forming. A fourth plant was visited for the purpose of observing plant testing of the cyanide precipitation system. Specific data from this facility are not included because: (1) the pH was usually well below the optimum level of 9.0; (2) the historical treatment data were not obtained using the standard cyanide analysis procedure; and (3) matched input-output data were not made available by the plant. Scanning the available data indicates that the raw waste CN level was in the range of 25.0 mg/l; the pH 7.5; and treated CN level was from 0.1 to 0.2 mg/l.

The concentrations are those of the stream entering and leaving the treatment system. Plant 1057 allowed a 27-minute retention time for the formation of the complex. The retention time for the other plants is not known. The data suggest that over a wide range of cyanide concentration in the raw waste, the concentration of cyanide can be reduced in the effluent stream to under 0.15 mg/l.

Application and Performance. Cyanide precipitation can be used when cyanide destruction is not feasible because of the presence of cyanide complexes which are difficult to destroy. Effluent concentrations of cyanide well below 0.15 mg/l are possible.

Advantages and Limitations. Cyanide precipitation is an inexpensive method of treating cyanide. Problems may occur when metal ions interfere with the formation of the complexes.

Demonstration Status. Although no plants currently use cyanide precipitation to treat aluminum forming wastewaters, it is used in at least six coil coating plants, two of which have both aluminum forming and aluminum coil coating operations.

The Agency believes that the technology is transferable to the aluminum forming category because untreated (raw) wastewater cyanide concentrations are of the same order of magnitude in both categories. In general, the concentrations of cyanide found in aluminum forming wastewater are within the range of concentrations found in coil coating wastewaters. In that this technology converts all cyanide species (that is, the entire range of cyanide species present) to complex cyanides, it is reasonable to assume that the technology would achieve the same performance in both categories.

In addition, cyanide compounds are used as accelerators in conversion coating operations in both categories. The fact that cyanide is present in wastewaters in both categories from similar operations and is treated by cyanide precipitation in six coil coating plants also provides support that comparable performance should be expected when the technology is applied to aluminum forming wastewater.

In assessing the homogeneity of the combined metals data base (CMDB) discussed in detail in this section, the Agency compared raw waste concentrations for metals among all of the categories considered, including aluminum forming and coil coating. Raw wastewaters from both categories are homogeneous with respect to mean pollutant concentrations. Consequently, to the extent that there are metals present that interfere with the performance of this technology, they are accounted for in the performance data used in developing the coil coating treatment effectiveness concentrations. Therefore, aluminum forming plants using this technology will achieve performance comparable to that experienced by plants in the coil coating category.

4. Granular Bed Filtration

Filtration occurs in nature as the surface ground waters are cleansed by sand. Silica sand, anthracite coal, and garnet are common filter media used in water treatment plants. These are usually supported by gravel. The media may be used singly or in combination. The multi-media filters may be arranged to maintain relatively distinct layers by balancing the forces of gravity, flow, and buoyancy on the individual particles. This is accomplished by selecting appropriate filter flow rates (gpm/sq-ft), media grain size, and density.

Granular bed filters may be classified in terms of filtration rate, filter media, flow pattern, or method of pressurization. Traditional rate classifications are slow sand, rapid sand, and high rate mixed media. In the slow sand filter, flux or hydraulic loading is relatively low, and removal of collected solids to clean the filter is therefore relatively infrequent. The filter is often cleaned by scraping off the inlet face (top) of the sand bed. In the higher rate filters, cleaning is frequent and is accomplished by a periodic backwash, opposite to the direction of normal flow.

A filter may use a single medium such as sand or diatomaceous earth (Figure VII-32a), but dual (Figure VII-32d) and mixed (multiple) media (Figure VII-32e) filters allow higher flow rates and efficiencies. The dual media filter usually consists of a fine bed of sand under a coarser bed of anthracite coal. The coarse coal removes most of the influent solids, while the fine sand performs a polishing function. At the end of the backwash, the fine sand settles to the bottom because it is denser than the coal, and the filter is ready for normal operation. The mixed media filter operates on the same principle, with the finer, denser media at the bottom and the coarser, less dense media at the top. The usual arrangement is garnet at the bottom (outlet end) of the bed, sand in the middle, and anthracite coal at the top. Some mixing of these layers occurs and is, in fact, desirable.

The flow pattern is usually top-to-bottom, but other patterns are sometimes used. Upflow filters (Figure VII-32b) are sometimes used, and in a horizontal filter the flow is horizontal. In a biflow filter (Figure VII-32c), the influent enters both the top and the bottom and exits laterally. The advantage of an upflow filter is that with an upflow backwash the particles of a single filter medium are distributed and maintained in the desired coarse-to-fine (bottom-to-top) arrangement. The disadvantage is that the bed tends to become fluidized, which ruins filtration efficiency. The biflow design is an attempt to overcome this problem.

The classic granular bed filter operates by gravity flow; however, pressure filters are fairly widely used. They permit higher solids loadings before cleaning and are advantageous when the filter effluent must be pressurized for further downstream treatment. In addition, pressure filter systems are often less costly for low to moderate flow rates.

Figure VII-6 depicts a high rate, dual media, gravity downflow granular bed filter, with self-stored backwash. Both filtrate and backwash are piped around the bed in an arrangement that permits gravity upflow of the backwash, with the stored filtrate serving as backwash. Addition of the indicated coagulant and polyelectrolyte usually results in a substantial improvement in filter performance.

Auxiliary filter cleaning is sometimes employed in the upper few inches of filter beds. This is conventionally referred to as surface wash and is accomplished by water jets just below the surface of the expanded bed during the backwash cycle. These jets enhance the scouring action in the bed by increasing the agitation.

An important feature for successful filtration and backwashing is the underdrain. This is the support structure for the bed. The underdrain provides an area for collection of the filtered water without clogging from either the filtered solids or the media grains. In addition, the underdrain prevents loss of the media with the water, and during the backwash cycle it provides even flow distribution over the bed. Failure to dissipate the velocity head during the filter or backwash cycle will result in bed upset and the need for major repairs.

Several standard approaches are employed for filter underdrains. The simplest one consists of a parallel porous pipe imbedded under a layer of coarse gravel and manifolded to a header pipe for effluent removal. Other approaches to the underdrain system are known as the Leopold and Wheeler filter bottoms. Both of these incorporate false concrete bottoms with specific porosity configurations to provide drainage and velocity head dissipation.

Filter system operation may be manual or automatic. The filter backwash cycle may be on a timed basis, a pressure drop basis with a terminal value which triggers backwash, or a solids carryover basis from turbidity monitoring of the outlet stream. All of these schemes have been used successfully.

Application and Performance. Wastewater treatment plants often use granular bed filters for polishing after clarification, sedimentation, or other similar operations. Granular bed filtration thus has potential application to nearly all industrial plants. Chemical additives which enhance the upstream treatment equipment may or may not be compatible with or enhance the filtration process. Normal operation flow rates for various types of filters are

Slow Sand	2.04 - 5.30 l/sq m-hr
Rapid Sand	40.74 - 51.48 l/sq m-hr

High Rate Mixed Media	81.48 - 122.22 l/sq m-hr

Suspended solids are commonly removed from wastewater streams by filtering through a deep 0.3 to 0.9 m (1 to 3 feet) granular filter bed. The porous bed formed by the granular media can be designed to remove practically all suspended particles. Even colloidal suspensions (roughly 1 to 100 microns) are adsorbed on the surface of the media grains as they pass in close proximity in the narrow bed passages.

Properly operated filters following some preliminary treatment to reduce suspended solids below 200 mg/l should produce water with less than 10 mg/l TSS. For example, multimedia filters produced the effluent qualities shown in Table VII-9.

Advantages and Limitations. The principal advantages of granular bed filtration are its comparatively (to other filters) low initial and operating costs, reduced land requirements over other methods to achieve the same level of solids removal, and elimination of chemical additions to the discharge stream. However, the filter may require preliminary treatment if the solids level is high (over 100 mg/l). Operator training must be somewhat extensive due to the controls and periodic backwashing involved, and backwash must be stored and dewatered for economical disposal.

Operational Factors. Reliability: The recent improvements in filter technology have significantly improved filtration reliability. Control systems, improved designs, and good operating procedures have made filtration a highly reliable method of water treatment.

Maintainability: Deep bed filters may be operated with either manual or automatic backwash. In either case, they must be periodically inspected for media attrition, partial plugging, and leakage. Where backwashing is not used, collected solids must be removed by shoveling, and filter media must be at least partially replaced.

Solid Waste Aspects: Filter backwash is generally recycled within the wastewater treatment system, so that the solids ultimately appear in the clarifier sludge stream for subsequent dewatering. Alternatively, the backwash stream may be dewatered directly or, if there is no backwash, the collected solids may be disposed of in a suitable landfill. In either of these situations there is a solids disposal problem similar to that of clarifiers.

Demonstration Status. Deep bed filters are in common use in municipal treatment plants. Their use in polishing industrial clarifier effluent is increasing, and the technology is proven and conventional. Granular bed filtration is used in many manufacturing plants. As noted previously, however, little data are available characterizing the effectiveness of filters presently in use within the aluminum forming category.

5. Pressure Filtration

Pressure filtration works by pumping the liquid through a filter material which is impenetrable to the solid phase. The positive pressure exerted by the feed pumps or other mechanical means provides the pressure differential which is the principal driving force. Figure VII-15 represents the operation of one type of pressure filter.

A typical pressure filtration unit consists of a number of plates or trays which are held rigidly in a frame to ensure alignment and which are pressed together between a fixed end and a traveling end. On the surface of each plate is mounted a filter made of cloth or a synthetic fiber. The feed stream is pumped into the unit and passes through holes in the trays along the length of the press until the cavities or chambers between the trays are completely filled. The solids are then entrapped, and a cake begins to form on the surface of the filter material. The water passes through the fibers, and the solids are retained.

At the bottom of the trays are drainage ports. The filtrate is collected and discharged to a common drain. As the filter medium becomes coated with sludge, the flow of filtrate through the filter drops sharply, indicating that the capacity of the filter has been exhausted. The unit must then be cleaned of the sludge. After the cleaning or replacement of the filter media, the unit is again ready for operation.

Application and Performance. Pressure filtration is used in aluminum forming for sludge dewatering and also for direct removal of precipitated and other suspended solids from wastewater. Because dewatering is such a common operation in treatment systems, pressure filtration is a technique which can be found in many industries concerned with removing solids from their waste streams.

In a typical pressure filter, chemically preconditioned sludge detained in the unit for one to three hours under pressures varying from 5 to 13 atmospheres exhibited a final dry solids content between 25 and 50 percent.

Advantages and Limitations. The pressures which may be applied to a sludge for water removal by filter presses that are currently available range from 5 to 13 atmospheres. As a result, pressure filtration may reduce the amount of chemical pretreatment required for sludge dewatering. Sludge retained in the form of the filter cake has a higher percentage of solids than that from a centrifuge or vacuum filter. Thus, it can be easily accommodated by materials handling systems.

As a primary solids removal technique, pressure filtration requires less space than clarification and is well suited to streams with high solids loadings. The sludge produced may be disposed of without further dewatering, but the amount of sludge is increased by the use of filter precoat materials (usually diatomaceous earth). Also, cloth pressure filters often do not achieve as high a degree of effluent clarification as clarifiers or granular media filters.

Two disadvantages associated with pressure filtration in the past have been the short life of the filter cloths and lack of automation. New synthetic fibers have largely offset the first of these problems. Also, units with automatic feeding and pressing cycles are now available.

For larger operations, the relatively high space requirements, as compared to those of a centrifuge, could be prohibitive in some situations.

Operational Factors. Reliability: With proper pretreatment, design, and control, pressure filtration is a highly dependable system.

Maintainability: Maintenance consists of periodic cleaning or replacement of the filter media, drainage grids, drainage piping, filter pans, and other parts of the system. If the removal of the sludge cake is not automated, additional time is required for this operation.

Solid Waste Aspects: Because it is generally drier than other types of sludges, the filter sludge cake can be handled with relative ease. The accumulated sludge may be disposed by any of the accepted procedures depending on its chemical composition. The levels of toxic metals present in sludge from treating aluminum forming wastewater necessitate proper disposal.

Demonstration Status. Pressure filtration is a commonly used technology in many commercial applications. One aluminum forming plant is known to use pressure filtration for sludge dewatering.

6. Settling

Settling is a process which removes solid particles from a liquid matrix by gravitational force. This is done by reducing the velocity of the feed stream in a large volume tank or lagoon so that gravitational settling can occur. Figure VII-8 shows two typical settling devices.

Settling is often preceded by chemical precipitation which converts dissolved pollutants to solid form and by coagulation which enhances settling by coagulating suspended precipitates into larger, faster settling particles.

If no chemical pretreatment is used, the wastewater is fed into a tank or lagoon where it loses velocity and the suspended solids are allowed to settle out. Long retention times are generally required. Accumulated sludge can be collected either periodically or continuously and either manually or mechanically. Simple settling, however, may require excessively large catchments, and long retention times (days as compared with hours) to achieve high removal efficiencies. Because of this, addition of settling aids such as alum or polymeric flocculants is often economically attractive.

In practice, chemical precipitation often precedes settling, and inorganic coagulants or polyelectrolytic flocculants are usually added as well. Common coagulants include sodium sulfate, sodium aluminate, ferrous or ferric sulfate, and ferric chloride. Organic polyelectrolytes vary in structure, but all usually form larger floc particles than coagulants used alone.

Following this pretreatment, the wastewater can be fed into a holding tank or lagoon for settling, but is more often piped into a clarifier for the same purpose. A clarifier reduces space requirements, reduces retention time, and increases solids removal efficiency. Conventional clarifiers generally consist of a circular or rectangular tank with a mechanical sludge collecting device or with a sloping funnel-shaped bottom designed for sludge collection. In advanced settling devices, inclined plates, slanted tubes, or a lamellar network may be included within the clarifier tank in order to increase the effective settling area, increasing capacity. A fraction of the sludge stream is often recirculated to the inlet, promoting formation of a denser sludge.

Settling is based on the ability of gravity (Newton's Law) to cause small particles to fall or settle (Stoke's Law) through the fluid in which they are suspended. Presuming that the factors affecting chemical precipitation are controlled to achieve a readily settleable precipitate, the principle factors controlling settling are the particle characteristics and the upflow rate of the suspending fluid. When the effective settling area is great enough to allow settling, any increase in the effective settling area will produce no increase in solids removal.

Therefore, if a plant has installed equipment that provides the appropriate overflow rate, the precipitated lead in the effluent can effectively be removed. The number of settling devices operated in series or in parallel by a facility is not important with regard to suspended solids removal, but rather that the settling devices provide sufficient effective settling area.

Another important facet of sedimentation theory is that diminishing removal of suspended solids is achieved for a unit increase in the effective settling area. Generally, it has been found that suspended solids removal performance varies with the effective up-flow rate. Qualitatively the performance increases asymptotically to a maximum level beyond which a decrease in up-flow rate provides incrementally insignificant increases in removal. This maximum level is dictated by particle size distribution, density characteristic of the particles and the water matrix, chemicals used for precipitation and pH at which precipitation occurs.

Application or Performance. Settling or clarification is used in the aluminum forming category to remove precipitated metals. Settling can be used to remove most suspended solids in a particular waste stream; thus, it is used extensively by many different industrial waste treatment facilities. Because most metal ion pollutants are readily converted to solid metal hydroxide precipitates, settling is of particular use in those industries associated with metal production, metal finishing, metal working, and any other industry with high concentrations of metal ions in their wastewaters. In addition to toxic metals, suitably precipitated materials effectively removed by settling include aluminum, iron, manganese, cobalt, antimony, beryllium, molybdenum, fluoride, phosphate, and many others.

A properly operated settling system can efficiently remove suspended solids, precipitated metal hydroxides, and other impurities from wastewater. The performance of the process depends on a variety of factors, including the density and particle size of the solids, the effective charge on the suspended particles, and the types of chemicals used in pretreatment. The site of flocculant or coagulant addition also may significantly influence the effectiveness of clarification. If the flocculant is subjected to too much mixing before entering the clarifier, the complexes may be sheared and the settling effectiveness diminished. At the same time, the flocculant must have sufficient mixing and reaction time in order for effective set-up and settling to occur. Plant personel have observed that the line or trough leading into the clarifier is often the most efficient site for flocculant addition. The performance of simple settling is a function of the retention time, particle size and density, and the surface area of the basin.

The data displayed in Table VII-10 indicate suspended solids removal efficiencies in settling systems. The mean effluent TSS concentration obtained by the plants shown in Table VII-10 is 10.1 mg/l. Influent concentrations averaged 838 mg/l. The maximum effluent TSS value reported is 23 mg/l. These plants all use alkaline pH adjustment to precipitate metal hydroxides, and most add a coagulant or flocculant prior to settling.

Advantages and Limitations. The major advantage of simple settling is its simplicity as demonstrated by the gravitational settling of solid particular waste in a holding tank or lagoon. The major problem with simple settling is the long retention time necessary to achieve complete settling, especially if the specific gravity of the suspended matter is close to that of water. Some materials cannot be effectively removed by simple settling alone.

Settling performed in a clarifier is effective in removing slow-settling suspended matter in a shorter time and in less space than a simple settling system. Also, effluent quality is often better from a clarifier. The cost of installing and maintaining a clarifier, however, is substantially greater than the costs associated with simple settling.

Inclined plate, slant tube, and lamellar settlers have even higher removal efficiencies than conventional clarifiers, and greater capacities per unit area are possible. Installed costs for these advanced clarification systems are claimed to be one half the cost of conventional systems of similar capacity.

Operational Factors. Reliability: Settling can be a highly reliable technology for removing suspended solids. Sufficient retention time and regular sludge removal are important factors affecting the reliability of all settling systems. Proper control of pH adjustment, chemical precipitation, and coagulant or flocculant addition are additional factors affecting settling efficiencies in systems (frequently clarifiers) where these methods are used.

Those advanced settlers using slanted tubes, inclined plates, or a lamellar network may require prescreening of the waste in order to eliminate any fibrous materials which could potentially clog the system. Some installations are especially vulnerable to shock loadings, as from storm water runoff, but proper system design will prevent this.

Maintainability: When clarifiers or other advanced settling devices are used, the associated system utilized for chemical pretreatment and sludge dragout must be maintained on a regular basis. Routine maintenance of mechanical parts is also necessary. Lagoons require little maintenance other than periodic sludge removal.

Demonstration Status. Settling represents the typical method of solids removal and is employed extensively in industrial waste treatment. The advanced clarifiers are just beginning to appear in significant numbers in commercial applications. Twenty-nine aluminum forming plants use sedimentation or clarification.

7. Skimming

Pollutants with a specific gravity less than water will often float unassisted to the surface of the wastewater. Skimming removes these floating wastes. Skimming normally takes place in a tank designed to allow the floating material to rise and remain on the surface, while the liquid flows to an outlet located below the floating layer. Skimming devices are therefore suited to the removal of non-emulsified oils from raw waste streams. Common skimming mechanisms include the rotating drum type, which picks up oil from the surface of the water as it rotates. A doctor blade scrapes oil from the drum and collects it in a trough for disposal or reuse. The water portion is allowed to flow under the rotating drum. Occasionally, an underflow baffle is installed after the drum; this has the advantage of retaining any floating oil which escapes the drum skimmer. The belt type skimmer is pulled vertically through the water, collecting oil which is scraped off from the surface and collected in a drum. Gravity separators (Figure VII-33), such as the API type, utilize overflow and underflow baffles to skim a floating oil layer from the surface of the wastewater. An overflow-underflow baffle allows a small amount of wastewater (the oil portion) to flow over into a trough for disposition or reuse while the majority of the water flows underneath the baffle. This is followed by an overflow baffle, which is set at a height relative to the first baffle such that only the oil bearing portion will flow over the first baffle during normal plant operation. A diffusion device, such as a vertical slot baffle, aids in creating a uniform flow through the system and increasing oil removal efficiency.

Application and Performance. Oil skimming is applicable to any waste stream containing pollutants which float to the surface. It is commonly used to remove free oil, grease, and soaps. Skimming is often used in conjunction with air flotation or clarification in order to increase its effectiveness.

The removal efficiency of a skimmer is partly a function of the retention time of the water in the tank. Larger, more buoyant particles require less retention time than smaller particles. Thus, the efficiency also depends on the composition of the waste stream. The retention time required to allow phase separation and subsequent skimming varies from 1 to 15 minues, depending on the wastewater characteristics.

API or other gravity-type separators tend to be more suitable for use where the amount of surface oil flowing through the system is consistently significant. Drum and belt type skimmers are applicable to waste streams which evidence smaller amounts of floating oil and where surges of floating oil are not a problem. Using an API separator system in conjunction with a drum type skimmer would be a very effective method of removing floating contaminants from non-emulsified oily waste streams. Sampling data shown in Table VII-11 illustrate the capabilities of the technology with both extremely high and moderate oil influent levels.

These data are intended to be illustrative of the very high level of oil and grease removals attainable in a simple two stage oil removal system. Based on the performance of installations in a variety of manufacturing plants and permit requirements that are consistently achieved, it is determined that effluent oil levels may be reliably reduced below 10 mg/l with moderate influent concentrations. Very high concentrations of oil such as the 22 percent shown in Table VII-11 may require two step treatment to achieve this level.

Skimming which removes oil may also be used to remove base levels of organics. Plant sampling data show that many organic compounds tend to be removed in standard wastewater treatment equipment. Oil separation not only removes oil but also organics that are more soluble in oil than in water. Clarification removes organic solids directly and probably removes dissolved organics by adsorption on inorganic solids.

The source of these organic pollutants is not always known with certainty, although in metal forming operations they seem to derive mainly from various process lubricants. They are also sometimes present in the plant water supply, as additives to proprietary formulations of cleaners, or as the result of leaching from plastic lines and other materials.

High molecular weight organics in particular are much more soluble in organic solvents than in water. Thus they are much more concentrated in the oil phase that is skimmed than in the wastewater. The ratio of solubilities of a compound in oil and water phases is called the partition coefficient. The logarithm of the partition coefficients for 28 toxic organic compounds in octanol and water are:

PAH Priority Pollutant		Log Octanol/Water Partition Coefficient
1.	Acenaphthene	4.33
11.	1,1,1-Trichloroethane	2.17
13.	1,1-Dichloroethane	1.79
15.	1,1,2,2-Tetrachloroethane	2.56
18.	Bis(2-chloroethyl)ether	1.58
23.	Chloroform	1.97
29.	Dichloroethylene	1.48
39.	Fluoranthene	5.33
44.	Methylene chloride	1.25
64.	Pentachlorophenol	5.01
66.	Bis(2-ethylhexyl)phthalate	8.73
67.	Butyl benzyl phthalate	5.80
68.	Di-n-butyl phthalate	5.20
72.	Benzo(a)anthracene	5.61
73.	Benzo(a)pyrene	6.04
74.	3,4-Benzofluoranthene	6.57
75.	Benzo(k)fluoranthene	6.84
76.	Chrysene	5.61
77.	Acenaphthylene	4.07
78.	Anthracene	4.45
79.	Benzo(ghi)perylene	7.23
80.	Fluorene	4.18
81.	Phenanthrene	4.46
82.	Dibenzo(a,h)anthracene	5.97
83.	Indeno(1,2,3,cd)pyrene	7.66
84.	Pyrene	5.32
85.	Tetrachloroethylene	2.88
86.	Toluene	2.69

A review of priority organic compounds commonly found in metal forming operations waste streams indicated that incidental removal of these compounds often occurs as a result of oil removal or clarification processes. When all organics analyses from visited plants are considered, removal of organic compounds by other waste treatment technologies often appears to be marginal in most cases. However, when only raw waste concentrations of 0.05 mg/l or greater are considered, incidental organics removal becomes much more apparent. Lower values, those less than 0.05 mg/l, are more subject to analytical variation, while higher values indicate a significant presence of a given compound. When these factors are taken into account, the data indicate that most clarification and oil removal treatment systems remove significant amounts of the organic compounds present in the raw waste. The API oil-water separation system performed notably in this regard, as shown in Table VII-12.

The unit operation most applicable to removal of trace priority organics is adsorption, and chemical oxidation is another possibility. Biological degradation is not generally applicable because the organics are not present in sufficient concentration to sustain a biomass and because most of the organics are resistant to biodegradation.

Advantages and Limitations. Skimming as a pretreatment is effective in removing naturally floating waste material. It also improves the performance of subsequent downstream treatments. Many pollutants, particularly dispersed or emulsified oil, will not float "naturally" but require additional treatments. Therefore, skimming alone may not remove all the pollutants capable of being removed by air flotation or other more sophisticated technologies.

Operational Factors. Reliability: Because of its simplicity, skimming is a very reliable technique, requiring little operator supervision.

Maintainability: The skimming mechanism requires periodic lubrication, adjustment, and replacement of worn parts.

Solid Waste Aspects: The collected layer of debris must be disposed of by contractor removal, landfill, or incineration. Because relatively large quantities of water are present in the collected wastes, incineration is not always a viable disposal method.

Demonstration Status. Skimming is a common operation utilized extensively by industrial waste treatment systems.

MAJOR TECHNOLOGY EFFECTIVENESS

The performance of individual treatment technologies was presented above. Performance of operating systems is discussed here. Two different systems are considered: L&S (hydroxide precipitation and sedimentation or lime and settle) and LS&F (hydroxide precipitation, sedimentation, and filtration or lime, settle, and filter). Subsequently, an analysis of effectiveness of such systems is made to develop one-day maximum and ten-day and thirty-day average concentration levels to be used in regulating pollutants. Evaluation of the L&S and the LS&F systems is carried out on the assumption that chemical reduction of chromium, cyanide precipitation, oil skimming, and emulsion breaking are installed and operating properly where appropriate.

L&S Performance -- Combined Metals Data Base

A data base known as the "combined metals data base" (CMDB) was used to determine treatment effectiveness of lime and settle treatment for certain pollutants. The CMDB was developed over several years and has been used in a number of regulations.

During the development of coil coating and other categorical effluent limitations and standards, chemical analysis data were collected of wastewater (treatment influent) and treated wastewater (treatment effluent) from 55 plants (126 data days) sampled by EPA (or its contractor) using EPA sampling and chemical analysis protocols. These data are the initial data base for determining the effectiveness of L&S technology in treating nine pollutants. Each of these plants belongs to at least one of the following industry categories: aluminum forming, battery manufacturing, coil coating, copper forming, electroplating and porcelain enameling. All of the plants employ pH adjustment and hydroxide precipitation using lime or caustic, followed by Stokes' Law settling (tank, lagoon or clarifier) for solids removal. An analysis of this data was presented in the development documents for the proposed regulations for coil coating and porcelain enameling (January 1981). Prior to analyzing the data, some values were deleted from the data base. These deletions were made to ensure that the data reflect the performance of properly operated treatment systems. The following criteria were used in making these deletions:

- Plants where malfunctioning processes or treatment systems at the time of sampling were identified.
- Data days where pH was less than 7.0 for extended periods of time or TSS was greater than 50 mg/l (these are prima facie indications of poor operation).

In response to the coil coating and porcelain enameling proposals, some commenters claimed that it was inappropriate to use data from some categories for regulation of other categories. In response to these comments, the Agency reanalyzed the data. An analysis of variance was applied to the data for the 126 days of sampling to test the hypothesis of homogeneous plant mean raw and treated effluent levels across categories by pollutant. This analysis is described in the report, "A Statistical Analysis of the Combined Metals Industries Effluent Data" which is in the administrative record supporting this rulemaking. Homogeneity is the absence of statistically discernable differences among the categories, while heterogeneity is the opposite, i.e., the presence of statistically discernable differences. The main conclusion drawn from the analysis of variance is that, with the exception of electroplating, the categories included in the data base are generally homogeneous with regard to mean pollutant concentrations in both raw and treated effluent. That is, when data from electroplating facilities are included in the analysis, the hypothesis of homogeneity across categories is rejected. When the electroplating data are removed from the analysis the conclusion changes substantially and the hypothesis of homogeneity across categories is not rejected. On the basis of this analysis, the electroplating data were removed from the data base used to determine limitations for final coil coating and porcelain enameling regulations and the proposed regulations for copper forming, aluminum forming and battery manufacturing, nonferrous metals (Phase I), and canmaking.

The statistical analysis provides support for the technical engineering judgement that electroplating wastewaters are different from the wastewaters of other industrial categories in the data base used to determine treatment effectiveness.

For the purpose of determining treatment effectiveness, additional data were deleted from the data base. These deletions were made, almost exclusively, in cases where effluent data points were associated with low influent values. This was done in two steps. First, effluent values measured on the same day as influent values that were less than or equal to 0.1 mg/l were deleted. Second, the remaining data were screened for cases in which all influent values at a plant were low although slightly above the 0.1 mg/l value. These data were deleted not as individual data points but as plant clusters of data that were consistently low and thus not relevant to assessing treatment. A few data points were also deleted where malfunctions not previously identified were recognized. The data basic to the CMDB are displayed graphically in Figures VII-4 to 12.

After all deletions, 148 data points from 19 plants remained. These data were used to determine the concentration basis of limitations derived from the CMDB used for the proposed aluminum forming regulations.

The CMDB was reviewed following its use in a number of proposed regulations (including aluminum forming). Comments pointed out a few errors in the data and the Agency's review identified a few transcription errors and some data points that were appropriate for inclusion in the data that had not been used previously because of errors in data record identification numbers. Documents in the record of this rulemaking identify all the changes, the reasons for the changes, and the effects of these changes on the data base. Other comments on the CMDB asserted that the data base was too small and that the statistical methods used were overly complex. Responses to specific comments are provided in a document included in the record of this rulemaking.

The Agency believes that the data base is adequate to determine effluent concentrations achievable with lime and settle treatment. The statistical methods employed in the analysis are well known and appropriate statistical references are provided in the documents in the record that describe the analysis.

The revised data base was re-examined for homogeneity. The earlier conclusions were unchanged. The categories show good overall homogeneity with respect to concentrations of the nine pollutants in both raw and treated wastewaters with the exception of electroplating.

The same procedures used in developing proposed limitations from the combined metals data base were then used on the revised data base. That is, certain effluent data associated with low influent values were deleted, and then the remaining data were fit to a lognormal distribution to determine limitations values. The deletion of data was again done in two steps. First, effluent values measured on the same day as influent values that were less than or equal to 0.1 mg/l were deleted. Second, the remaining data were screened for cases in which all influent values at a plant were low although slightly above the 0.1 mg/l value. These data were deleted not as individual data points but as plant clusters of data that were consistently low and thus not relevant to assessing treatment.

The revised combined metals data base used for this final regulation consists of 162 data points from 18 plants in the same industrial categories used at proposal. The changes that were made since proposal resulted in slight upward revisions of the concentration bases for the limitations and standards for zinc and nickel. The limitations for iron decrease slightly. The other limitations were unchanged. A comparison of Table VII-20 in the final development document with Table VII-20 in the proposal development document will show the exact magnitude of the changes.

The Agency is confident that the concentrations calculated from the combined metals data base accurately reflect the ability of lime and settle systems in aluminum forming plants to reduce the concentrations of the toxic metals in their raw waste streams. The Agency confirmed this judgment by comparing available discharge monitoring report (DMR) data from 12 aluminum forming plants. This comparison led to the conclusion that the concentrations calculated from the combined metals data base were achieved by many discharge points over long periods of time. The analysis of the DMR data is documented in the record of this rulemaking.

One-Day Effluent Values

The same procedures used to determine the concentration basis of the limitations for lime and settle treatment from the CMDB at proposal were used on the CMDB for the final limitations. The basic assumption underlying this determination of treatment effectiveness is that the data for a particular pollutant are lognormally distributed by plant. The lognormal has been found to provide a satisfactory fit to plant effluent data in a number of effluent guidelines categories and there was no evidence that the lognormal was not suitable in the case of the combined metals data. Thus, we assumed measurements of each pollutant from a particular plant, denoted by X, followed a lognormal distribution with a log mean μ, and log variance σ^2. The mean, variance, and 99th percentile of X are then:

$$\text{mean of } X = E(X) = \exp\,(\mu + \sigma^2/_2)$$
$$\text{variance of } X = V(X) = \exp\,(2\mu + \sigma^2)\,[\exp(\sigma^2) - 1]$$
$$\text{99th percentile} = X_{.99} = \exp\,(\mu + 2.33\sigma)$$

where exp is e, the base of the natural logarithm. The term lognormal is used because the logarithm of X has a normal distribution with mean μ and variance σ^2. Using the basic assumption of log normality, the actual treatment effectiveness was determined using a lognormal distribution that, in a sense, approximates the distribution of an average of the plants in the data base (i.e., an "average plant" distribution). The notion of an "average plant" distribution is not a strict statistical concept but is used here to determine limits that would represent the performance capability of an average of the plants in the data base.

This "average plant" distribution for a particular pollutant was developed as follows: the log mean was determined by taking the average of all the observations for the pollutant across plants. The log variance was determined by the pooled within plant variance. This is the weighted average of the plant variances. Thus, the log mean represents the average of all the data for the pollutant and the log variance represents the average of the plant log variances or average plant variability for the pollutant.

The one-day effluent values were determined as follows:

Let X_{ij} = the jth observation on a particular pollutant at plant i where

$i = 1, \ldots, I$
$j = 1, \ldots, J_i$
I = total number of plants

Ji = number of observations at plant i

Then $Yij = \ln Xij$

where ln means the natural logarithm.

Then Y = log mean over all plants

$$= \sum_{i=1}^{I} \sum_{j=1}^{Ji} Yij/n$$

where n = total number of observations

$$= \sum_{i=1}^{I} Ji$$

and $V(Y)$ = pooled log variance

$$= \frac{\sum_{i=1}^{I} (Ji - 1)\, Si^2}{\sum_{i=1}^{I} (Ji - 1)}$$

where Si^2 = log variance at plant i

$$= \sum_{j=i}^{Ji} (Yij - \bar{Y}i)^2 / (Ji - 1)$$

Yi = log mean at plant i

Thus, Y and V(Y) are the log mean and log variance, respectively, of the lognormal distribution used to determine the treatment effectiveness. The estimated mean and 99th percentile of this distribution form the basis for the long term average and daily maximum effluent limitations, respectively. The estimates are

$$\text{mean} = \hat{E}(X) = \exp(\bar{Y})\, \psi n(0.5V(Y))$$

$$_{99}\text{th percentile} = \hat{X}_{.99} = \exp\left[\bar{Y} + 2.33\sqrt{V(Y)}\ \right]$$

where ψ (.) is a Bessel function and exp is e, the base of the natural logarithms (see Aitchison, J. and J. A. C. Brown, The Lognormal Distribution, Cambridge University Press, 1963). In cases where zeros were present in the data, a generalized form of the lognormal, known as the delta distribution was used (see Aitchison and Brown, op. cit., Chapter 9).

For certain pollutants, this approach was modified slightly to ensure that well operated lime and settle plants in all CMDB categories could meet the concentrations calculated from the CMDB. For instance, after excluding the electroplating data and other data that did not reflect pollutant removal or proper treatment, the effluent copper data from the copper forming plants were statistically significantly greater than the copper data from the other plants. This indicated that copper forming plants might have difficulty achieving an effluent concentration value calculated from copper data from all the CMDB categories. Thus, copper effluent values shown in Table VII-14 are based only on the copper effluent data from the copper forming plants. That is, the log mean for copper is the mean of the logs of all copper values from the copper forming plants only and the log variance is the pooled log variance of the copper forming plant data only. In the case of cadmium, after excluding the electroplating data and data that did not reflect removal or proper treatment, there were insufficient data to estimate the log variance for cadmium. The variance used to determine the values shown in Table VII-14 for cadmium was estimated by pooling the within plant variances for all the other metals. Thus, the cadmium variability is the average of the plant variability averaged over all the other metals. The log mean for cadmium is the mean of the logs of the cadmium observations only. A complete discussion of the data and calculations for all the metals is contained in the administrative record for this rulemaking.

Average Effluent Values

Average effluent values that form the basis for the monthly limitations were developed in a manner consistent with the method used to develop one-day treatment effectiveness in that the lognormal distribution used for the one-day effluent values was also used as the basis for the average values. That is, we assume a number of consecutive measurements are drawn from the distribution of daily measurements. The average of 10 measurements taken during a month was used as the basis for the monthly average limitations. The approach used for the 10 measurements value was employed previously in regulations for other categories and was proposed for the aluminum forming category. That is, the distribution of the average of 10 samples from a lognormal was approximated by another lognormal distribution. Although the approximation is not precise theoretically, there is empirical evidence based on effluent data from a number of categories that the lognormal is an adequate approximation for the distribution of small samples. In the course of previous work the approximation was verified in a computer simulation study (see

"Development Document for Existing Sources Pretreatment Standards for the Electroplating Point Source Category," EPA 440/1-79/003, U.S. Environmental Protection Agency, Washington, D.C., August 1979). The average values were developed assuming independence of the observations although no particular sampling scheme was assumed.

Ten-Sample Average:

The formulas for the 10-sample limitations were derived on the basis of simple relationships between the mean and variance of the distributions of the daily pollutant measurements and the average of 10 measurements. We assume that the daily concentration measurements for a particular pollutant (denoted by X) follow a lognormal distribution with log mean and log variance denoted by μ and σ^2, respectively. Let X_{10} denote the mean of 10 consecutive measurements. The following relationships then hold, assuming the daily measurements are independent:

$$\text{mean of } \bar{X}_{10} = E(\bar{X}_{10}) = E(X)$$
$$\text{variance of } \bar{X}_{10} = V(\bar{X}_{10}) = V(X) \div 10$$

where E(X) and V(X) are the mean and variance of X, respectively, defined above. We then assume that X_{10} follows a lognormal distribution with log mean μ_{10} and log standard deviation σ^2_{10}. The mean and variance of X_{10} are then

$$E(\bar{X}_{10}) = \exp(\mu_{10} + 0.5\sigma^2_{10})$$

$$V(\bar{X}_{10}) = \exp(2\mu_{10} + \sigma^2_{10}) [\exp(\sigma^2_{10})-1].$$

Now, μ_{10} and σ^2_{10} can be derived in terms of μ and σ_2 as

$$\mu_{10} = \mu + \sigma^2/_2 - 0.5 \ln [1+ \exp(\sigma^2 - 1)/N]$$

$$\sigma^2_{10} = \ln [1 + (\exp(\sigma^2) - {}^1/N]$$

Therefore, μ_{10} and σ^2_{10} can be estimated using the above relationships and the estimates of μ and σ^2 obtained for the underlying lognormal distribution. The 10-sample limitation value was determined by the estimate of the approximate 99th percentile of the distribution of the 10 sample average given by

$$X_{10}(.99) = \exp(\hat{\mu}_{10} + 2.33\,\sigma_{10})$$

where $\hat{\mu}_{10}$ and σ_{10} are the estimates of μ_{10} and σ_{10}, respectively.

Thirty-Sample Average:

Monthly average values based on the average of 30 daily measurements were also calculated. These are included because monthly limitations based on 30 samples have been used in the past and for comparison with the 10 sample values. The average values based on 30 measurements are determined on the basis of a statistical result known as the Central Limit Theorem. This Theorem states that, under general and nonrestrictive assumptions, the distribution of a sum of a number of random variables, say n, is approximated by the normal distribution. The approximation improves as the number of variables, n, increases. The Theorem is quite general in that no particular distributional form is assumed for the distribution of the individual variables. In most applications (as in approximating the distribution of 30-day averages) the Theorem is used to approximate the distribution of the average of n observations of a random variable. The result makes it possible to compute approximate probability statements about the average in a wide range of cases. For instance, it is possible to compute a value below which a specified percentage (e.g., 99 percent) of the averages of n observations are likely to fall. Most textbooks state that 25 or 30 observations are sufficient for the approximation to be valid. In applying the Theorem to the distribution of 30-day average effluent values, we approximate the distribution of the average of 30 observations drawn from the distribution of daily measurements and use the estimated 99th percentile of this distribution. The monthly limitations based on 10 consecutive measurements were determined using the lognormal approximation described above because 10 measurements were, in this case, considered too small a number for use of the Central Limit Theorem.

Thirty-Sample Average Calculation

The formulas for the 30-sample average were based on an application of the Central Limit Theorem. According to the Theorem, the average of 30 observations drawn from the distribution of daily measurements, denoted by X_{30}, is approximately normally distributed. The mean and variance of X_{30} are

$$\text{mean of } \bar{X}_{30} = E(\bar{X}_{30}) = E(X)$$
$$\text{variance of } \bar{X}_{30} = V(\bar{X}_{30}) = V(X) \div 30$$

The 30-sample average value was determined by the estimate of the approximate 99th percentile of the distribution of the 30-sample average given by

$$\hat{\bar{X}}_{30}(.99) = \hat{E}(X)=2.33 \sqrt{\hat{V}(X) \div 30}$$

where $\hat{E}(X) = \exp(\overline{Y})\psi n(0.5V(Y))$

and $\hat{V}(X) = \exp(2\overline{Y})[\psi n(2V(Y)) - n\left\{\frac{n-2}{n-1}\right\} V(Y)]$.

The formulas for $\hat{E}(X)$ and $\hat{V}(X)$ are estimates of $E(X)$ and $V(X)$, respectively, given in Aitchison, J. and J. A. C. Brown, *The Lognormal Distribution*, Cambridge University Press, 1963, page 45.

Application

In response to the proposed coil coating and porcelain enameling regulations, the Agency received comments pointing out that permits usually required less than 30 samples to be taken during a month while the monthly average used as the basis for permits and pretreatment requirements is based on the average of 30 samples.

In applying the treatment effectiveness values to regulations we have considered the comments, examined the sampling frequency required by many permits, and considered the change in values of averages depending on the number of consecutive sampling days in the averages. The most common frequency of sampling required in permits is about 10 samples per month or slightly greater than twice weekly. The 99th percentiles of the distribution of averages of 10 consecutive sampling days are not substantially different from the 99th percentile of the distribution's 30-day average. (Compared to the one-day maximum, the 10-day average is about 80 percent of the difference between one and 30-day values). Hence, the 10-day average provides a reasonable basis for a monthly average and is typical of the sampling frequency required by existing permits.

The monthly average is to be achieved in all permits and pretreatment standards regardless of the number of samples required to be analyzed and averaged by the permit or the pretreatment authority.

Additional Pollutants

Ten additional pollutant parameters were evaluated to determine the performance of lime and settle treatment systems in removing them from industrial wastewater. Performance data for these parameters are not part of the CMDB, so data available to the Agency from other categories have been used to determine the long-term average performance of lime and settle technology for each pollutant. These data indicate that the concentrations shown in Table VII-14 are reliably attainable with hydroxide precipitation and settling. Treatment effectiveness values were calculated by multiplying the mean performance from Table VII-14, by the appropriate variability factor. (The variability factor is the ratio of the value of concern to the mean.) The pooled variability factors are: one-day maximum - 4.100; 10-day average - 1.821; and 30-day average - 1.618. These one-, ten-, and thirty-day values are tabulated in Table VII-20.

In establishing which data were suitable for use in Table VII-14 two factors were heavily weighed: (1) the nature of the wastewater; and (2) the range of pollutants or pollutant matrix in the raw wastewater. These data have been selected from processes that generate dissolved metals in the wastewater and which are generally free from complexing agents. The pollutant matrix was evaluated by comparing the concentrations of pollutants found in the raw wastewaters with the range of pollutants in the raw wastewaters of the combined metals data set. These data are displayed in Tables VII-15 and VII-16 and indicate that there is sufficient similarity in the raw wastes to logically assume transferability of the treated pollutant concentrations to the combined metals data base. The available data on these added pollutants do not allow a homogeneity analysis as was performed on the combined metals data base. The data source for each added pollutant is discussed separately.

Antimony (Sb) - The achievable performance for antimony is based on data from a battery and secondary lead plant. Both EPA sampling data and recent permit data (1978 - 1982) confirm the achievability of 0.7 mg/l in the battery manufacturing wastewater matrix included in the combined data set.

Arsenic (As) - The achievable performance of 0.5 mg/l for arsenic is based on permit data from two nonferrous metals manufacturing plants. The untreated wastewater matrix shown in Table VII-16 is comparable with the combined data set matrix.

Beryllium (Be) - The treatability of beryllium is transferred from the nonferrous metals manufacturing industry. The 0.3 performance is achieved at a beryllium plant with the comparable untreated wastewater matrix shown in Table VII-16.

Mercury (Hg) - The 0.06 mg/l treatability of mercury is based on data from four battery plants. The untreated wastewater matrix at these plants was considered in the combined metals data set.

Selenium (Se) - The 0.30 mg/l treatability of selenium is based on recent permit data from one of the nonferrous metals manufacturing plants also used for antimony performance. The untreated wastewater matrix for this plant is shown in Table VII-16.

Silver (Ag) - The treatability of silver is based on a 0.1 mg/l treatability estimate from the inorganic chemicals industry. Additional data supporting a treatability as stringent or more stringent than 0.1 mg/l are also available from seven nonferrous metals manufacturing plants. The untreated wastewater matrix for these plants is comparable and summarized in Table VII-16.

Thallium (Tl) - The 0.50 mg/l treatability for thallium is transferred from the inorganic chemicals industry. Although no untreated wastewater data are available to verify comparability with the combined metals data set plants, no other sources of data for thallium treatability could be identified.

Aluminum (Al) - The 2.24 mg/l treatability of aluminum is based on the mean performance of three aluminum forming plants and one coil coating plant. At proposal this was based on the mean performance of one coil coating plant and one aluminum forming plant; data from two aluminum forming plants sampled after proposal were used in determining treatment effectiveness. All of these plants are from categories considered in the combined metals data set, assuring untreated wastewater matrix comparability.

Cobalt (Co) - The 0.05 mg/l treatability is based on nearly complete removal of cobalt at a porcelain enameling plant with a mean untreated wastewater cobalt concentration of 4.31 mg/l. In this case, the analytical detection using aspiration techniques for this pollutant is used as the basis of the treatability. Porcelain enameling was considered in the combined metals data base, assuring untreated wastewater matrix comparability.

Fluoride (F) - The 14.5 mg/l treatability of fluoride is based on the mean performance (216 samples) of an electronics and electrical component manufacturing plant. The untreated wastewater matrix for this plant shown in Table VII-16 is comparable to the combined metals data set.

Phosphorus (P) - The 4.08 mg/l treatability of phosphorus is based on the mean of 44 samples including 19 samples from the Combined Metals Data Base and 25 samples from the electroplating data base. Inclusion of electroplating data with the combined metals data was considered appropriate, since the remvoal mechanism for phosphorus is a precipitation reaction with calcium rather than hydroxide.

LS&F Performance

Tables VII-17 and VII-18 show long-term data from two plants which have well operated precipitation-settling treatment followed by filtration. The wastewaters from both plants contain pollutants from metals processing and finishing operations (multi-category). Both plants reduce hexavalent chromium before neutralizing and precipitating metals with lime. A clarifier is used to remove much of the solids load and a filter is used to "polish" or complete removal of suspended solids. Plant A uses pressure filtration, while Plant B uses a rapid sand filter.

Raw wastewater data were collected only occasionally at each facility and the raw wastewater data are presented as an indication of the nature of the wastewater treated. Data from Plant A were received as a statistical summary and are presented as received. Raw laboratory data were collected at Plant B and reviewed for spurious points and discrepancies. The method of treating the data base is discussed below under lime, settle, and filter treatment effectiveness.

Table VII-19 shows long-term data for zinc and cadmium removal at Plant C, a primary zinc smelter, which operates a LS&F system. These data represent about four months (103 data days) taken immediately before the smelter was closed, and have been arranged similarily to Plants A and B for comparison and use.

These data are presented to demonstrate the performance of precipitation-settling-filtration (LS&F) technology under actual operating conditions and over a long period of time.

It should be noted that the iron content of the raw waste of plants A and B is high while that for Plant C is low. This results, for plants A and B, in co-precipitation of toxic metals with iron. Precipitation using high-calcium lime for pH control yields the results shown in Table VII-19. Plant operating personnel indicate that this chemical treatment combination (sometimes with polymer assisted coagulation) generally produces better and more consistent metals removal than other combinations of sacrificial metal ions and alkalis.

The LS&F performance data presented here are based on systems that provide polishing filtration after effective L&S treatment. As previously shown, L&S treatment is equally applicable to wastewaters from the five categories because of the homogeneity of its raw and treated wastewaters, and other factors. Because of the similarity of the wastewaters after L&S treatment, the Agency believes these wastewaters are equally amenable to treatment using polishing filters added to the L&S treatment system. The Agency concludes the LS&F data based on porcelain enameling and nonferrous smelting and refining is directly applicable to the aluminum forming, copper forming, battery manufacturing, coil coating, and metal molding and casting categories, and the canmaking subcategory as well as it is to porcelain enameling and nonferrous metals smelting and refining.

Analysis of Treatment System Effectiveness

Data are presented in Table VII-13 showing the mean, one-day, 10-day, and 30-day values for nine pollutants examined in the L&S metals data base. The pooled variability factor for seven pollutants (excluding cadmium because of the small number of data points) was determined and is used to estimate one-day, 10-day, and 30-day values. (The variability factor is the ratio of the value of concern to the mean: the pooled variability factors are: one-day maximum - 4.100; ten-day average - 1.821; and 30-day average - 1.618.) For values not calculated from the CMDB as previously discussed, the mean value for pollutants shown in Table VII-15 were multiplied by the variability factors to derive the value to obtain the one-, ten- and 30-day values. These are tabulated in Table VII-20.

The treatment effectiveness for sulfide precipitation and filtration has been calculated similarly. Long term average values shown in Table VII-6 have been multiplied by the appropriate variability factor to estimate one-day maximum, and 10-day and 30-day average values. Variability factors developed in the combined metals data base were used because the raw wastewaters are identical and the treatment methods are similar as both use chemical precipitation and solids removal to control metals.

LS&F technology data are presented in Tables VII-17 and VII-18. These data represent two operating plants (A and B) in which the technology has been installed and operated for some years. Plant A data were received as a statistical summary and are presented without change. Plant B data were received as raw laboratory analysis data. Discussions with plant personnel indicated that operating experiments and changes in materials and reagents and occasional operating errors had occurred during the data collection period. No specific information was available on those variables. To sort out high values probably caused by methodological factors from random statistical variability, or data noise, the Plant B data were analyzed. For each of the four pollutants (chromium, nickel, zinc, and iron), the mean and standard deviation (sigma) were calculated for the entire data set. A data day was removed from the complete data set when any individual pollutant concentration for that day exceeded the sum of the mean plus three sigma for that pollutant. Fifty-one data days (from a total of about 1,300) were eliminated by this method.

Another approach was also used as a check on the above method of eliminating certain high values. The minimum values of raw wastewater concentrations from Plant B for the same four pollutants were compared to the total set of values for the corresponding pollutants. Any day on which the treated wastewater pollutant concentration exceeded the minimum value selected from raw wastewater concentrations for that pollutant was discarded. Forty-five days of data were eliminated by that procedure. Forty-three days of data in common were eliminated by either procedures. Since common engineering practice (mean plus 3 sigma) and logic (treated waste should be less than raw waste) seem to coincide, the data base with the 51 spurious data days eliminated is the basis for all further analysis. Range, mean, standard deviation and mean plus two standard deviations are shown in Tables VII-17 and VII-18 for Cr, Cu, Ni, Zn, and Fe.

The Plant B data were separated into 1979, 1978, and total data base (six years) segments. With the statistical analysis from Plant A for 1978 and 1979 this in effect created five data sets in which there is some overlap between the individual years and total data sets from Plant B. By comparing these five parts it is apparent that they are quite similar and all appear to be from the same family of numbers. The largest mean found among the five data sets for each pollutant was selected as the long-term mean for LS&F technology and is used as the LS&F mean in Table VII-20.

Plant C data were used as a basis for cadmium removal performance and as a check on the zinc values derived from Plants A and B. The cadmium data is displayed in Table VII-19 and is incorporated into Table VII-20 for LS&F. The zinc data were analyzed for compliance with the one-day and 30-day values in Table VII-20; no zinc value of the 103 data points exceeded the one-day zinc value of 1.02 mg/l. The 103 data points were separated into blocks of 30 points and averaged. Each of the three full 30-day averages was less than the Table VII-20 value of 0.31 mg/l. Additionally, the Plant C raw wastewater pollutant concentrations (Table VII-19) are well within the range of raw wastewater concentrations of the combined metals data base (Table VII-15), further supporting the conclusion that Plant C wastewater data are compatible with similar data from Plants A and B.

Concentration values for regulatory use are displayed in Table VII-20. Mean one-day, ten-day, and 30-day values for L&S for nine pollutants were taken from Table VII-13; the remaining L&S values were developed using the mean values in Table VII-14 and the mean variability factors discussed above.

LS&F mean values for Cd, Cr, Ni, Zn, and Fe are derived from Plants A, B, and C as discussed above. One-, ten-, and thirty-day values are derived by applying the variability factor developed from the pooled data base for the specific pollutant to the mean for that pollutant. Other LS&F values are calculated using the long-term average or mean and the appropriate variability factors. Mean values for LS&F for pollutants not already discussed are derived by reducing the L&S mean by one-third. The onethird reduction was established after examining the percent reduction in concentrations going from L&S to LS&F data for Cd, Cr, Ni, Zn, and Fe. The average reduction is 0.3338 or one-third.

Concentration values for regulatory use are displayed in Table VII-20. Mean one-day, ten-day, and thirty-day values for L&S for nine pollutants were taken from Table VII-13; the remaining L&S values were developed using the mean values in Table VII-14 and the mean variability factors discussed above.

LS&F mean values for Cd, Cr, Ni, Zn and Fe are derived from plants A, B, and C as discussed above. One-, ten-, and thirty-day values are derived by applying the variability factor developed from the pooled data base for the specific pollutant to the mean for that pollutant. Other LS&F values are calculated using the long term average or mean and the appropriate variability factors.

Copper levels achieved at plants A and B may be lower than generally achievable because of the high iron content and low copper content of the raw wastewaters. Therefore, the mean concentration value achieved from plants A and B is not used; LS&F mean for copper is derived from the L&S technology.

L&S cyanide mean levels shown in Table VII-8 are ratioed to one-day, ten-day, and 30-day values using mean variability factors. LS&F mean cyanide is calculated by applying the ratios of removals for L&S and LS&F as discussed previously for LS&F metals limitations. The cyanide performance was arrived at by using the average metal variability factors. The treatment method used here is cyanide precipitation. Because cyanide precipitation is limited by the same physical processes as the metal precipitation, it is expected that the variabilities will be similar. Therefore, the average of the metal variability factors has been used as a basis for calculating the cyanide one-day, ten-day, and 30-day average treatment effectiveness values.

The filter performance for removing TSS as shown in Table VII-9 yields a mean effluent concentration of 2.61 mg/l and calculates to a ten-day average of 4.33, 30-day average of 3.36 mg/l, and a one-day maximum of 8.88. These calculated values more than amply support the classic thirty-day and one-day values of 10 and 15, respectively, which are used for LS&F.

Although iron concentrations were decreased in some LS&F operations, some facilities using that treatment introduce iron compounds to aid settling. Therefore, the one-day, ten-day, and

30-day values for iron at LS&F were held at the L&S level so as to not unduly penalize the operations which use the relatively less objectionable iron compounds to enhance removals of toxic metals.

MINOR TECHNOLOGIES

Several other treatment technologies were considered for possible application in BPT or BAT. These technologies are presented here with a full discussion for most of them. A few are described only briefly because of limited technical development.

8. Chemical Emulsion Breaking

Chemical treatment is often used to break stable oil-in-water (O-W) emulsions. An O-W emulsion consists of oil dispersed in water, stabilized by electrical charges and emulsifying agents. A stable emulsion will not separate or break down without some form of treatment.

Once an emulsion is broken, the difference in specific gravities allows the oil to float to the surface of the water. Solids usually form a layer between the oil and water, since some oil is retained in the solids. The longer the retention time, the more complete and distinct the separation between the oil, solids, and water will be. Often other methods of gravity differential separation, such as air flotation or rotational separation (e.g., centrifugation), are used to enhance and speed separation. A schematic flow diagram of one type of application is shown in Figure VII-35.

The major equipment required for chemical emulsion breaking includes: reaction chambers with agitators, chemical storage tanks, chemical feed systems, pumps, and piping.

Emulsifiers may be used in the plant to aid in stabilizing or forming emulsions. Emulsifiers are surface-active agents which alter the characteristics of the oil and water interface. These surfactants have rather long polar molecules. One end of the molecule is particularly soluble in water (e.g., carboxyl, sulfate, hydroxyl, or sulfonate groups) and the other end is readily soluble in oils (an organic group which varies greatly with the different surfactant type). Thus, the surfactant emulsifies or suspends the organic material (oil) in water. Emulsifiers also lower the surface tension of the O-W emulsion as a result of solvation and ionic complexing. These emulsions must be destabilized in the treatment system.

Application and Performance. Emulsion breaking is applicable to waste streams containing emulsified oils or lubricants such as rolling and drawing emulsions.

Treatment of spent O-W emulsions involves the use of chemicals to break the emulsion followed by gravity differential separation. Factors to be considered for breaking emulsions are type of chemicals, dosage and sequence of addition, pH, mechanical shear and agitation, heat, and retention time.

Polymers, alum, ferric chloride, and organic emulsion breakers, break emulsions by neutralizing repulsive charges between particles, precipitating or salting out emulsifying agents, or altering the interfacial film between the oil and water so it is readily broken. Reactive cations (e.g., H(+1), Al(+3), Fe(+3), and cationic polymers) are particularly effective in breaking dilute O-W emulsions. Once the charges have been neutralized or the interfacial film broken, the small oil droplets and suspended solids will be adsorbed on the surface of the floc that is formed, or break out and float to the top. Various types of emulsion-breaking chemicals are used for the various types of oils.

If more than one chemical is required, the sequence of addition can make quite a difference in both breaking efficiency and chemical dosages.

pH plays an important role in emulsion breaking, especially if cationic inorganic chemicals, such as alum, are used as coagulants. A depressed pH in the range of 2 to 4 keeps the aluminum ion in its most positive state where it can function most effectively for charge neutralization. After some of the oil is broken free and skimmed, raising the pH into the 6 to 8 range with lime or caustic will cause the aluminum to hydrolyze and precipitate as aluminum hydroxide. This floc entraps or adsorbs destabilized oil droplets which can then be separated from the water phase. Cationic polymers can break emulsions over a wider pH range and thus avoid acid corrosion and the additional sludge generated from neutralization; however, an inorganic flocculant is usually required to supplement the polymer emulsion breaker's adsorptive properties.

Mixing is important in breaking O-W emulsions. Proper chemical feed and dispersion is required for effective results. Mixing also causes collisions which help break the emulsion, and subsequently helps to agglomerate droplets.

In all emulsions, the mix of two immiscible liquids has a specific gravity very close to that of water. Heating lowers the viscosity and increases the apparent specific gravity differential between oil and water. Heating also increases the frequency of droplet collisions, which helps to rupture the interfacial film.

Oil and grease and suspended solids performance data are shown in Table VII-21. Data were obtained from sampling at operating plants and a review of the current literature. This type of treatment is proven to be reliable and is considered state-ofthe-art for aluminum forming emulsified oily wastewaters.

Advantages and Limitations. Advantages gained from the use of chemicals for breaking O-W emulsions are the high removal efficiency potential and the possibility of reclaiming the oily waste. Disadvantages are corrosion problems associated with acid-alum systems, skilled operator requirements for batch treatment, chemical sludges produced, and poor cost-effectiveness for low oil concentrations.

Operational Factors. Reliability: Chemical emulsion breaking is a very reliable process. The main control parameters, pH and temperature, are fairly easy to control.

Maintainability: Maintenance is required on pumps, motors, and valves, as well as periodic cleaning of the treatment tank to remove any accumulated solids. Energy use is limited to mixers and pumps.

Solid Waste Aspects: The surface oil and oily sludge produced are usually hauled away by a licensed contractor. If the recovered oil has a sufficiently low percentage of water, it may be burned for its fuel value or processed and reused.

Demonstration Status. Sixteen plants in the aluminum forming category currently break emulsions with chemicals. Eight plants chemically break spent rolling oil emulsions with chemicals, one plant breaks its rolling and drawing emulsions, one plant breaks its rolling oils and degreasing solvent, one plant breaks its direct chill casting contact cooling water, scrubber liquor, and sawing oil, and one plant breaks its direct chill casting contact cooling water and extrusion press heat treatment contact cooling water.

9. Thermal Emulsion Breaking

Dispersed oil droplets in a spent emulsion can be destabilized by the application of heat to the waste. One type of technology commonly used in the metals and mechanical products industries is the evaporation-decantation-condensation process, also called thermal emulsion breaking (TEB), which separates the emulsion waste into distilled water, oils and other floating materials, and sludge. Raw waste is fed to a main reaction chamber. Warm air is passed over a large revolving drum which is partially submerged in the waste. Some water evaporates from the surface of the drum and is carried upward through a filter and a condensing unit. The condensed water is discharged or reused as process makeup, while the air is reheated and returned to the evaporation stage. As the water evaporates in the main chamber, oil concentration increases. This enhances agglomeration and gravity separation of oils. The separated oils and other floating materials flow over a weir into a decanting chamber. A rotating drum skimmer picks up oil from the surface of the decanting chamber and discharges it for possible reprocessing or contractor removal. Meanwhile, oily water is being drawn from the bottom of the decanting chamber, reheated, and sent back into the main conveyorized chamber. Solids which settle out in the main chamber are removed by a conveyor belt. This conveyor belt, called a flight scraper, moves slowly so as not to interfere with the settling of suspended solids.

Application and Performance. Thermal emulsion breaking technology can be applied to the treatment of spent emulsions in the aluminum forming category.

The performance of a thermal emulsion breaker is dependent primarily on the characteristics of the raw waste and proper maintenance and functioning of the process components. Some emulsions may contain volatile compounds which could escape with the distilled water. In systems where the water is recycled back to process, however, this problem is essentially eliminated.

Advantages and Limitations. Advantages of the thermal emulsion breaking process include high percentages of oil removal (at least 99 percent in most cases), the separation of floating oil from settleable sludge solids, and the production of distilled water which is available for process reuse. In addition, no chemicals are required and the operation is automated, factors which reduce operating costs. Disadvantages of the process are the energy requirement for water evaporation and, if intermittently operated, the necessary installation of a large storage tank.

Operational Factors. Reliability: Thermal emulsion breaking is a very reliable process for the treatment of emulsified oil wastes.

Maintainability: The thermal emulsion breaking process requires minimal routine maintenance of the process components, and periodic disposal of the sludge and oil.

Solid Waste Aspects: The thermal emulsion breaking process generates sludge which must be properly disposed of.

Demonstration Status. Thermal emulsion breaking is used in metals and mechanical products industries. It is a proven method of effectively treating emulsified wastes.

10. Carbon Adsorption

The use of activated carbon to remove dissolved organics from water and wastewater is a long demonstrated technology. It is one of the most efficient organic removal processes available. This sorption process is reversible, allowing activated carbon to be regenerated for reuse by the application of heat and steam or solvent. Activated carbon has also proved to be an effective adsorbent for many toxic metals, including mercury. Regeneration of carbon which has adsorbed significant metals, however, may be difficult.

The term activated carbon applies to any amorphous form of carbon that has been specially treated to give high adsorption capacities. Typical raw materials include coal, wood, coconut shells, petroleum base residues, and char from sewage sludge pyrolysis. A carefully controlled process of dehydration, carbonization, and oxidation yields a product which is called activated carbon. This material has a high capacity for adsorption due primarily to the large surface area available for adsorption, 500 to 1,500 m^2/sq m resulting from a large number of internal pores. Pore sizes generally range from 10 to 100 angstroms in radius.

Activated carbon removes contaminants from water by the process of adsorption, or the attraction and accumulation of one substance on the surface of another. Activated carbon preferentially adsorbs organic compounds over other species and, because of this selectivity, is particularly effective in removing organic compounds from aqueous solution.

Carbon adsorption requires preliminary treatment to remove excess suspended solids, oils, and greases. Suspended solids in the influent should be less than 50 mg/l to minimize backwash requirements; a downflow carbon bed can handle much higher levels (up to 2,000 mg/l), but requires frequent backwashing. Backwashing more than two or three times a day is not desirable; at 50 mg/l suspended solids, one backwash will suffice. Oil and grease should be less than about 10 mg/l. A high level of dissolved inorganic material in the influent may cause problems with thermal carbon reactivation (i.e., scaling and loss of activity) unless appropriate preventive steps are taken. Such steps might include pH control, softening, or the use of an acid wash on the carbon prior to reactivation.

Activated carbon is available in both powdered and granular form. An adsorption column packed with granular activated carbon is shown in Figure VII-35. A schematic of an individual adsorption column is shown in Figure VII-17. Powdered carbon is less expensive per unit weight and may have slightly higher adsorption capacity, but it is more difficult to handle and to regenerate.

Application and Performance. Isotherm tests have indicated that activated carbon is very effective in adsorbing 65 percent of the toxic organic pollutants and is reasonably effective for another 22 percent. Specifically, for the organics of particular interest, activated carbon is very effective in removing 2,4-dimethylphenol, fluoranthene, isophorone, naphthalene, all phthalates, and phenanthrene. Activated carbon is reasonably effective on 1,1,1-trichloroethane, 1,1-dichloroethane, phenol, and toluene.

Table VII-22 summarizes the treatability effectiveness for most of the toxic organic priority pollutants by activated carbon as compiled by EPA. Table VII-23 summarizes classes of organic compounds together with samples of organics that are readily adsorbed on carbon.

Advantages and Limitations. The major benefits of carbon treatment include applicability to a wide variety of organics and high removal efficiency. Inorganics such as cyanide, chromium, and mercury are also removed effectively. Variations in concentration and flow rate are well tolerated. The system is compact, and recovery of adsorbed materials is sometimes practical. However, destruction of adsorbed compounds often occurs during thermal regeneration. If carbon cannot be thermally regenerated, it must be disposed of along with any adsorbed pollutants. The capital and operating costs of thermal regeneration are relatively high. Cost surveys show that thermal regeneration is generally economical when carbon usage exceeds about 1,000 lb/day. Carbon cannot remove low molecular weight or highly soluble organics. It also has a low tolerance for suspended solids, which must be removed in most systems to at least 50 mg/l in the influent water.

Operational Factors. Reliability: This system should be very reliable with upstream protection and proper operation and maintenance procedures.

Maintainability: This system requires periodic regeneration or replacement of spent carbon and is dependent upon raw waste load and process efficiency.

Solid Waste Aspects: Solid waste from this process is contaminated activated carbon that requires disposal. Carbon that undergoes regeneration reduces the solid waste problem by reducing the frequency of carbon replacement.

Demonstration Status. Carbon adsorption systems have been demonstrated to be practical and economical in reducing COD, BOD, and related parameters in secondary municipal and industrial wastewaters; in removing toxic or refractory organics from isolated industrial wastewaters; in removing and recovering certain organics from wastewaters; and in removing and some times recovering selected inorganic chemicals from aqueous wastes. Carbon adsorption is a viable and economic process for organic waste streams containing up to 1 to 5 percent of refractory or toxic organics. Its applicability for removal of inorganics such as metals has also been demonstrated.

11. Flotation

Flotation is the process of causing particles such as metal hydroxides or oil to float to the surface of a tank where they can be concentrated and removed. This is accomplished by releasing gas bubbles which attach to the solid particles, increasing their buoyancy and causing them to float. In principle, this process is the opposite of sedimentation. Figure VII-22 shows one type of flotation system.

Flotation is used primarily in the treatment of wastewater streams that carry heavy loads of finely divided suspended solids or oil. Solids having a specific gravity only slightly greater than 1.0, which would require abnormally long sedimentation times, may be removed in much less time by flotation.

This process may be performed in several ways: foam, dispersed air, dissolved air, gravity, and vacuum flotation are the most commonly used techniques. Chemical additives are often used to enhance the performance of the flotation process.

The principal difference among types of flotation is the method of generating the minute gas bubbles (usually air) in a suspension of water and small particles. Chemicals may be used to improve the efficiency with any of the basic methods. The following paragraphs describe the different flotation techniques and the method of bubble generation for each process.

Froth Flotation - Froth flotation is based on differences in the physiochemical properties in various particles. Wettability and surface properties affect the ability of the particles to attach themselves to gas bubbles in an aqueous medium. In froth flotation, air is blown through the solution containing flotation reagents. The particles with water repellant surfaces stick to air bubbles as they rise and are brought to the surface. A mineralized froth layer, with mineral particles attached to air bubbles, is formed. Particles of other minerals which are readily wetted by water do not stick to air bubbles and remain in suspension.

Dispersed Air Flotation - In dispersed air flotation, gas bubbles are generated by introducing the air by means of mechanical agitation with impellers or by forcing air through porous media. Dispersed air flotation is used mainly in the metallurgical industry.

Dissolved Air Flotation - In dissolved air flotation, bubbles are produced by releasing air from a superstaturated solution under relatively high pressure. There are two types of contact between the gas bubbles and particles. The first type is predominant in the flotation of flocculated materials and involves the entrapment of rising gas bubbles in the flocculated particles as they increase in size. The bond between the bubble and particle is one of physical capture only. The second type of contact is one of adhesion. Adhesion results from the intermolecular attraction exerted at the interface between the solid particle and the gaseous bubble.

Vacuum Flotation - This process consists of saturating the wastewater with air either directly in an aeration tank, or by permitting air to enter on the suction of a wastewater pump. A partial vacuum is applied, which causes the dissolved air to come out of solution as minute bubbles. The bubbles attach to solid particles and rise to the surface to form a scum blanket, which is normally removed by a skimming mechanism. Grit and other heavy solids that settle to the bottom are generally raked to a central sludge pump for removal. A typical vacuum flotation unit consists of a covered cylindrical tank in which a partial vacuum is maintained. The tank is equipped with scum and sludge removal mechanisms. The floating material is continuously swept to the tank periphery, automatically discharged into a scum trough, and removed from the unit by a pump also under partial vacuum. Auxiliary equipment includes an aeration tank for saturating the wastewater with air, a tank with a short retention time for removal of large bubbles, vacuum pumps, and sludge pumps.

Application and Performance. The primary variables for flotation design are pressure, feed solids concentration, and retention period. The suspended solids in the effluent decrease, and the concentration of solids in the float increases, with increasing retention period. When the flotation process is used primarily for clarification, a retention period of 20 to 30 minutes is adequate for separation and concentration.

Advantages and Limitations. Some advantages of the flotation process are the high levels of solids separation achieved in many applications, the relatively low energy requirements, and the adaptability to meet the treatment requirements of different waste types. Limitations of flotation are that it often requires addition of chemicals to enhance process performance and that it generates large quantities of solid waste.

Operational Factors. Reliability: Flotation systems normally are very reliable with proper maintenance of the sludge collector mechanism and the motors and pumps used for aeration.

Maintainability: Routine maintenance is required on the pumps and motors. The sludge collector mechanism is subject to possible corrosion or breakage and may require periodic replacement.

Solid Waste Aspects: Chemicals are commonly used to aid the flotation process by creating a surface or a structure that can easily adsorb or entrap air bubbles. Inorganic chemicals, such as the aluminum and ferric salts, and activated silica, can bind the particulate matter together and create a structure that can entrap air bubbles. Various organic chemicals can change the nature of either the air-liquid interface or the solid-liquid interface, or both. These compounds usually collect on the interface to bring about the desired changes. The added chemicals plus the particles in solution combine to form a large volume of sludge which must be further treated or properly disposed of.

Demonstration Status. Flotation is a fully developed process and is readily available for the treatment of a wide variety of industrial waste streams. Dissolved air flotation technology is used by can manufacturing plants to remove oil and grease in the wastewater from can wash lines. It is not currently used to treat aluminum forming wastewaters.

12. Centrifugation

Centrifugation is the application of centrifugal force to separate solids and liquids in a liquid-solid mixture or to effect concentration of the solids. The application of centrifugal force is effective because of the density differential normally found between the insoluble solids and the liquid in which they are contained. As a waste treatment procedure, centrifugation is most often applied to dewatering of sludges. One type of centrifuge is shown in Figure VII-18.

There are three common types of centrifuges: the disc, basket, and conveyor type. All three operate by removing solids under the influence of centrifugal force. The fundamental difference between the three types is the method by which solids are collected in and discharged from the bowl.

In the disc centrifuge, the sludge feed is distributed between narrow channels that are present as spaces between stacked conical discs. Suspended particles are collected and discharged continuously through small orifices in the bowl wall. The clarified effluent is discharged through an overflow weir.

A second type of centrifuge which is useful in dewatering sludges is the basket centrifuge. In this type of centrifuge, sludge feed is introduced at the bottom of the basket, and solids collect at the bowl wall while clarified effluent overflows the lip ring at the top. Since the basket centrifuge does not have provision for continuous discharge of collected cake, operation requires interruption of the feed for cake discharge for a minute or two in a 10- to 30-minute overall cycle.

The third type of centrifuge commonly used in sludge dewatering is the conveyor type. Sludge is fed through a stationary feed pipe into a rotating bowl in which the solids are settled out against the bowl wall by centrifugal force. From the bowl wall, the solids are moved by a screw to the end of the machine, at which point they are discharged. The liquid effluent is discharged through ports after passing the length of the bowl under centrifugal force.

Application and Performance. Virtually all industrial waste treatment systems producing sludge can use centrifugation to dewater it. Centrifugation is currently being used by a wide range of industries.

The performance of sludge dewatering by centrifugation depends on the feed rate, the rotational velocity of the drum, and the sludge composition and concentration. Assuming proper design and operation, the solids content of the sludge can be increased to 20 to 35 percent.

Advantages and Limitations. Sludge dewatering centrifuges have minimal space requirements and show a high degree of effluent clarification. The operation is simple, clean, and relatively inexpensive. The area required for a centrifuge system installation is less than that required for a filter system or sludge drying bed of equal capacity, and the initial cost is lower.

Centrifuges have a high power cost that partially offsets the low initial cost. Special consideration must also be given to providing sturdy foundations and soundproofing because of the vibration and noise that result from centrifuge operation. Adequate electrical power must also be provided since large motors are required. The major difficulty encountered in the operation of centrifuges has been the disposal of the concentrate which is relatively high in suspended, non-settling solids.

Operational Factors. Reliability: Centrifugation is highly reliable with proper control of factors such as sludge feed, consistency, and temperature. Pretreatment such as grit removal and coagulant addition may be necessary, depending on the composition of the sludge and on the type of centrifuge employed.

Maintainability: Maintenance consists of periodic lubrication, cleaning, and inspection. The frequency and degree of inspection required varies depending on the type of sludge solids being dewatered and the maintenance service conditions. If the sludge is abrasive, it is recommended that the first inspection of the rotating assembly be made after approximately 1,000 hours of operation. If the sludge is not abrasive or corrosive, then the initial inspection might be delayed. Centrifuges not equipped with a continuous sludge discharge system require periodic shutdowns for manual sludge cake removal.

Solid Waste Aspects: Sludge dewatered in the centrifugation process may be disposed of by landfill. The clarified effluent (centrate), if high in dissolved or suspended solids, may require further treatment prior to discharge.

Demonstration Status. Centrifugation is currently used in a great many commercial applications to dewater sludge. Work is underway to improve the efficiency, increase the capacity, and lower the costs associated with centrifugation.

13. Coalescing

The basic principle of coalescence involves the preferential wetting of a coalescing medium by oil droplets which accumulate on the medium and then rise to the surface of the solution as they combine to form larger particles. The most important requirements for coalescing media are wettability for oil and large surface area. Monofilament line is sometimes used as a coalescing medium.

Coalescing stages may be integrated with a wide variety of gravity oil separation devices, and some systems may incorporate several coalescing stages. In general, a preliminary oil skimming step is desirable to avoid overloading the coalescer.

One commercially marketed system for oily waste treatment combines coalescing with inclined plate separation and filtration. In this system, the oily wastes flow into an inclined plate settler. This unit consists of a stack of inclined baffle plates in a cylindrical container with an oil collection chamber at the top. The oil droplets rise and impinge upon the undersides of the plates. They then migrate upward to a guide rib that directs the oil to the oil collection chamber, from which oil is discharged for reuse or disposal.

The oily water continues on through another cylinder containing replaceable filter cartridges that remove suspended particles from the waste. From there the wastewater enters a final cylinder in which the coalescing material is housed. As the oily water passes through the many small, irregular, continuous passages in the coalescing material, the oil droplets coalesce and rise to an oil collection chamber.

Application and Performance. Coalescing is used to treat oily wastes that do not separate readily in simple gravity systems. The three stage system described above has achieved effluent concentrations of 10 to 15 mg/l oil and grease from raw waste concentrations of 1,000 mg/l or more.

Advantages and Limitations. Coalescing allows removal of oil droplets too finely dispersed for conventional gravity separation-skimming technology. It also can significantly reduce the residence times (and therefore separator volumes) required to achieve separation of oil from some wastes. Because of its simplicity, coalescing provides generally high reliability and low capital and operating costs. Coalescing is not generally effective in removing soluble or chemically stabilized emulsified oils. To avoid plugging, coalescers must be protected by pretreatment from the very high concentrations of free oil and grease and suspended solids. Frequent replacement of prefilters may be necessary when raw waste oil concentrations are high.

Operational Factors. Reliability: Coalescing is inherently highly reliable since there are no moving parts and the coalescing substrate (monofilament, etc.) is inert in the process and therefore not subject to frequent regeneration or replacement requirements. Large loads or inadequate preliminary treatment, however, may result in plugging or bypass of coalescing stages.

Maintainability: Maintenance requirements are generally limited to replacement of the coalescing medium on an infrequent basis.

Solid Waste Aspects: No appreciable solid waste is generated by this process.

Demonstration Status. Coalescing has been fully demonstrated in industries generating oily wastewater, although none are known to be in use at any aluminum forming facility.

14. Cyanide Oxidation by Chlorine

Cyanide oxidation using chlorine is widely used in industrial waste treatment to oxidize cyanide. Chlorine can be utilized in either the elemental or hypochlorite forms. This classic procedure can be illustrated by the following two step chemical reaction:

1. $\mathrm{Cl_2 + NaCN + 2NaOH} \text{ ----> } \mathrm{NaCNO + 2NaCl + H_2O}$
2. $\mathrm{3Cl_2 + 6\ NaOH + 2\ NaCNO} \text{ ----\% } \mathrm{NaHCO_3 + N_2 + 6NaCl + 2H_2O}$

The reaction presented as equation (2) for the oxidation of cyanate is the final step in the oxidation of cyanide. A complete system for the alkaline chlorination of cyanide is shown in Figure VII-19.

The alkaline chlorination process oxidizes cyanides to carbon dioxide and nitrogen. The equipment often consists of an equalization tank followed by two reaction tanks, although the reaction can be carried out in a single tank. Each tank has an electronic recorder-controller to maintain required conditions with respect to pH and oxidation reduction potential (ORP). In the first reaction tank, conditions are adjusted to oxidize cyanides to cyanates. To effect the reaction, chlorine is metered to the reaction tank as required to maintain the ORP in the range of 350 to 400 millivolts, and 50 percent aqueous caustic soda is added to maintain a pH range of 9.5 to 10. In the second reaction tank, conditions are maintained to oxidize cyanate to carbon dioxide and nitrogen. The desirable ORP and pH for this reaction are 600 millivolts and a pH of 8.0. Each of the reaction tanks is equipped with a propeller agitator designed to provide approximately one turnover per minute. Treatment by the batch process is accomplished by using two tanks, one for collection of water over a specified time period, and one tank for the treatment of an accumulated batch. If dumps of concentrated wastes are frequent, another tank may be required to equalize the flow to the treatment tank. When the holding tank is full, the liquid is transferred to the reaction tank for treatment. After treatment, the supernatant is discharged and the sludges are collected for removal and ultimate disposal.

Application and Performance. The oxidation of cyanide waste by chlorine is a classic process and is found in most industrial plants using cyanide. This process is capable of achieving effluent levels of free cyanide that are nondetectable. The process is potentially applicable to aluminum forming facilities where cyanide is a component in conversion coating formulations or is added as a corrosion inhibitor in heat treatment operations.

Advantages and Limitations. Some advantages of chlorine oxidation for handling process effluents are operation at ambient temperature, suitability for automatic control, and low cost. Disadvantages include the need for careful pH control, possible chemical interference in the treatment of mixed wastes, and the potential hazard of storing and handling chlorine gas. If organic compounds are present, toxic chlorinated organics may be generated. Alkaline chlorination is not effective in treating metallocyanide complexes, such as the ferrocyanide.

Operational Factors. Reliability: Chlorine oxidation is highly reliable with proper monitoring and control, and proper pretreatment to control interfering substances.

Maintainability: Maintenance consists of periodic removal of sludge and recalibration of instruments.

Solid Waste Aspects: There is no solid waste problem associated with chlorine oxidation.

Demonstration Status. The oxidation of cyanide wastes by chlorine is a widely used process in plants using cyanide in cleaning and metal processing baths.

15. Cyanide Oxidation by Ozone

Ozone is a highly reactive oxidizing agent which is approximately 10 times more soluble than oxygen on a weight basis in water. Ozone may be produced by several methods, but the silent electrical discharge method is predominant in the field. The silent electrical discharge process produces ozone by passing oxygen or air between electrodes separated by an insulating material. A complete ozonation system is represented in Figure VII-20.

Application and Performance. Ozonation has been applied commercially to oxidize cyanides, phenolic chemicals, and organometal complexes. Its applicability to photographic wastewaters has been studied in the laboratory with good results. Ozone is used in industrial waste treatment primarily to oxidize cyanide to cyanate and to oxidize phenols and dyes to a variety of colorless nontoxic products.

Oxidation of cyanide to cyanate is illustrated below:

$$CN^- + O_3 \longrightarrow CNO^- + O_2$$

Continued exposure to ozone will convert the cyanate formed to carbon dioxide and ammonia; however, this is not economically practical.

Ozone oxidation of cyanide to cyanate requires 1.8 to 2.0 pounds ozone per pound of CN^-; complete oxidation requires 4.6 to 5.0 pounds ozone per pound of CN^-. Zinc, copper and nickel cyanides are easily destroyed to a nondetectable level, but cobalt and iron cyanides are more resistant to ozone treatment.

Advantages and Limitations. Some advantages of ozone oxidation for handling process effluents are its suitability to automatic control and on-site generation and the fact that reaction products are not chlorinated organics and no dissolved solids are added in the treatment step. Ozone in the presence of activated carbon, ultraviolet, and other promoters shows promise of reducing reaction time and improving ozone utilization, but the process at present is limited by high capital expense, possible chemical interference in the treatment of mixed wastes, and an energy requirement of 25 kwh/kg of ozone generated. Cyanide is not economically oxidized with O_3 beyond the cyanate form.

Operational Factors. Reliability: Ozone oxidation is highly reliable with proper monitoring and control, and proper preliminary treatment to control interfering substances.

Maintainability: Maintenance consists of periodic removal of sludge, and periodic renewal of filters and desiccators required for the input of clean dry air; filter life is a function of input concentrations of detrimental constituents.

Solid Waste Aspects: Preliminary treatment to eliminate substances which will interfere with the process may be necessary. Dewatering of sludge generated in the ozone oxidation process or in an "in-line" process may be desirable prior to disposal.

16. Cyanide Oxidation by Ozone with UV Radiation

One of the modifications of the ozonation process is the simultaneous application of ultraviolet light and ozone for the treatment of wastewater, including treatment of halogenated organics. The combined action of these two forms produces reactions by photolysis, photosensitization, hydroxylation, oxygenation, and oxidation. The process is unique because several reactions and reaction species are active simultaneously.

Ozonation is facilitated by ultraviolet absorption because both the ozone and the reactant molecules are raised to a higher energy state so that they react more rapidly. In addition, free radicals for use in the reaction are readily hydrolyzed by the water present. The energy and reaction intermediates created by the introduction of both ultraviolet and ozone greatly reduce the amount of ozone required compared with a system using ozone alone. Figure VII-21 shows a three-stage UV-ozone system. A system to treat mixed cyanides requires preliminary treatment that involves chemical coagulation, sedimentation, clarification, equalization, and pH adjustment.

Application and Performance. The ozone-UV radiation process was developed primarily for cyanide treatment in the electroplating and color photo-processing areas. It has been successfully applied to mixed cyanides and organics from organic chemicals manufacturing processes. The process is particularly useful for treatment of complexed cyanides such as ferricyanide, copper cyanide, and nickel cyanide, that are resistant to ozone.

Demonstration Status. Ozone combined with UV radiation is a relatively new technology. Four units are currently in operation and all four treat cyanide-bearing waste. Ozone-UV treatment could be used in aluminum forming plants to destroy cyanide present in waste streams from some conversion coating and heat treatment operations.

17. Cyanide Oxidation by Hydrogen Peroxide

Hydrogen peroxide oxidation removes both cyanide and metals in cyanide-containing wastewaters. In this process, cyanide-bearing waters are heated to 49°C to 54°C (120°F to 130°F) and the pH is adjusted to 10.5 to 11.8. Formalin (37 percent formaldehyde) is added while the tank is vigorously agitated. After two to five minutes, a proprietary peroxygen compound (41 percent hydrogen peroxide with a catalyst and additives) is added. After an hour of mixing, the reaction is complete. The cyanide is converted to cyanate and the metals are precipitated as oxides or hydroxides. The metals are then removed from solution by either settling or filtration.

The main equipment required for this process is two holding tanks equipped with heaters and air spargers or mechanical stirrers. These tanks may be used in a batch or continuous fashion, with one tank being used for treatment while the other is being filled. A settling tank or a filter is needed to concentrate the precipitate.

Application and Performance. The hydrogen peroxide oxidation process is applicable to cyanide-bearing wastewaters, especially those containing metal-cyanide complexes. In terms of waste reduction performance, this process can reduce total cyanide to less than 0.1 mg/l and the zinc or cadmium concentrations to less than 1.0 mg/l.

Advantages and Limitations. Chemical costs are similar to those for alkaline chlorination using chlorine and lower than those for treatment with hypochlorite. All free cyanide reacts and is completely oxidized to the less toxic cyanate state. In addition, the metals precipitate and settle quickly, and they may be recoverable in many instances; however, the process requires energy expenditures to heat the wastewater prior to treatment.

Demonstration Status. This treatment process was introduced in 1971 and is used in several facilities. No aluminum forming plants use oxidation by hydrogen peroxide.

18. Evaporation

Evaporation is a concentration process. Water is evaporated from a solution, increasing the concentration of solute in the remaining solution. If the resulting water vapor is condensed back to liquid water, the evaporation-condensation process is called distillation. However, to be consistent with industry terminology, evaporation is used in this report to describe both processes. Both atmospheric and vacuum evaporation are commonly used in industry today. Specific evaporation techniques are shown in Figure VII-22 and discussed below.

Atmospheric evaporation could be accomplished simply by boiling the liquid. However, to aid evaporation, heated liquid is sprayed on an evaporation surface, and air is blown over the surface and subsequently released to the atmosphere. Thus, evaporation occurs by humidification of the air stream, similar to a drying process. Equipment for carrying out atmospheric evaporation is quite similar for most applications. The major element is generally a packed column with an accumulator bottom. Accumulated wastewater is pumped from the base of the column, through a heat exchanger, and back into the top of the column, where it is sprayed into the packing. At the same time, air drawn upward through the packing by a fan is heated as it contacts the hot liquid. The liquid partially vaporizes and humidifies the air stream. The fan then blows the hot, humid air to the outside atmosphere. A scrubber is often unnecessary because the packed column itself acts as a scrubber.

Another form of atmospheric evaporator also works on the air humidification principle, but the evaporated water is recovered for reuse by condensation. These air humidification techniques operate well below the boiling point of water and can utilize waste process heat to supply the energy required.

In vacuum evaporation, the evaporation pressure is lowered to cause the liquid to boil at reduced temperatures. All of the water vapor is condensed and, to maintain the vacuum condition, noncondensible gases (air in particular) are removed by a vacuum pump. Vacuum evaporation may be either single or double effect. In double effect evaporation, two evaporators are used, and the water vapor from the first evaporator (which may be heated by steam) is used to supply heat to the second evaporator. As it supplies heat, the water vapor from the first evaporator condenses. Approximately equal quantities of wastewater are evaporated in each unit; thus, the double effect system evaporates twice the amount of water that a single effect system does, at nearly the same cost in energy but with added capital cost and complexity. The double effect technique is thermodynamically possible because the second evaporator is maintained at lower pressure (higher vacuum) and, therefore, lower evaporation temperature. Vacuum evaporation equipment may be classified as submerged tube or climbing film evaporation units.

Another means of increasing energy efficiency is vapor recompression evaporation, which enables heat to be transferred from the condensing water vapor to the evaporating wastewater. Water vapor generated from incoming wastewaters flows to a vapor compressor. The compressed steam then travels through the wastewater via an enclosed tube or coil in which it condenses as heat is transferred to the surrounding solution. In this way the compressed vapor serves as a heating medium. After condensation, this distillate is drawn off continuously as the clean water stream. The heat contained in the compressed vapor is used to head the wastewater, and energy costs for system operation are reduced.

In the most commonly used submerged tube evaporator, the heating and condensing coil are contained in a single vessel to reduce capital cost. The vacuum in the vessel is maintained by an eductor-type pump, which creates the required vacuum by the flow of the condenser cooling water through a venturi. Wastewater accumulates in the bottom of the vessel, and it is evaporated by means of submerged steam coils. The resulting water vapor condenses as it contacts the condensing coils in the top of the vessel. The condensate then drips off the condensing coils into a collection trough that carries it out of the vessel. Concentrate is removed from the bottom of the vessel.

The major elements of the climbing film evaporator are the evaporator, separator, condenser, and vacuum pump. Wastewater is "drawn" into the system by the vacuum so that a constant liquid level is maintained in the separator. Liquid enters the steam-jacketed evaporator tubes, and part of it evaporates so that a mixture of vapor and liquid enters the separator. The design of the separator is such that the liquid is continuously circulated from the separator to the evaporator. The vapor entering the separator flows out through a mesh entrainment separator to the condenser, where it is condensed as it flows down through the condenser tubes. The condensate, along with any entrained air, is pumped out of the bottom of the condenser by a liquid ring vacuum pump. The liquid seal provided by the condensate keeps the vacuum in the system from being broken.

Application and Performance. Both atmospheric and vacuum evaporation are used in many industrial plants, mainly for the concentration and recovery of process solutions. Many of these evaporators also recover water for rinsing. Evaporation has also been applied to recovery of phosphate metal-cleaning solutions.

In theory, evaporation should yield a concentrate and a deionized condensate. Actually, carry-over has resulted in condensate metal concentrations as high as 10 mg/l, although the usual level is less than 3 mg/l, pure enough for most final rinses. The condensate may also contain organic brighteners and antifoaming agents. These can be removed with an activated carbon bed, if necessary. Samples from one plant showed 1,900 mg/l zinc in the feed, 4,570 mg/l in the concentrate, and 0.4 mg/l in the condensate. Another plant had 416 mg/l copper in the feed and 21,800 mg/l in the concentrate. Chromium analysis for that plant indicated 5,060 mg/l in the feed and 27,500 mg/l in the concentrate. Evaporators are available in a range of capacities, typically from 15 to 75 gph, and may be used in parallel arrangements for processing of higher flow rates.

Advantages and Limitations. Advantages of the evaporation process are that it permits recovery of a wide variety of process chemicals, and it is often applicable to concentration or removal of compounds which cannot be accomplished by any other means. The major disadvantage is that the evaporation process consumes relatively large amounts of energy for the evaporation of water. However, the recovery of waste heat from many industrial processes (e.g., diesel generators, incinerators, boilers, and furnaces) should be considered as a source of this heat for a totally integrated evaporation system. Also, in some cases solar heating could be inexpensively and effectively applied to evaporation units. For some applications, preliminary treatment may be required to remove solids or bacteria which tend to cause fouling in the condenser or evaporator. The buildup of scale on the evaporator surfaces reduces the heat transfer efficiency and may present a maintenance problem or increase operating cost. However it has been demonstrated that fouling of the heat transfer surfaces can be avoided or minimized for certain dissolved solids by maintaining a seed slurry which provides preferential sites for precipitate deposition. In addition, low temperature differences in the evaporator will eliminate nucleate boiling and supersaturation effects. Steam distillable impurities in the process stream are carried over with the product water and must be handled by preliminary or post treatment.

Operational Factors. Reliability: Proper maintenance will ensure a high degree of reliability for the system. Without such attention, rapid fouling or deterioration of vacuum seals may occur, especially when handling corrosive liquids.

Maintainability: Operating parameters can be automatically controlled. Preliminary treatment may be required, as well as periodic cleaning of the system. Regular replacement of seals, especially in a corrosive environment, may be necessary.

Solid Waste Aspects: With only a few exceptions, the process does not generate appreciable quantities of solid waste.

Demonstration Status. Evaporation is a fully developed, commercially available wastewater treatment system. It is used extensively to recover plating chemicals in the electroplating industry and a pilot-scale unit has been used in connection with phosphating of aluminum. Proven performance in silver recovery indicates that evaporation could be a useful treatment operation for the photographic industry, as well as for metal finishing. Vapor compression evaporation has been pratically demonstrated in a number of industries, including chemical manufacturing, food processing, pulp and paper and metal working.

19. Gravity Sludge Thickening

In the gravity thickening process, dilute sludge is fed from a primary settling tank or clarifier to a thickening tank where rakes stir the sludge gently to densify it and to push it to a central collection well. The supernatant is returned to the primary settling tank. The thickened sludge that collects on the bottom of the tank is pumped to dewatering equipment or hauled away. Figure VII-24 shows the construction of a gravity thickener.

Application and Performance. Thickeners are generally used in facilities where the sludge is to be further dewatered by a compact mechanical device such as a vacuum filter or centrifuge. Doubling the solids content in the thickener substantially reduces capital and operating cost of the subsequent dewatering device and also reduces cost for hauling. The process is potentially applicable to almost any industrial plant.

Organic sludges from sedimentation units of 1 to 2 percent solids concentration can usually be gravity thickened to 6 to 10 percent; chemical sludges can be thickened to 4 to 6 percent.

Advantages and Limitations. The principal advantage of a gravity sludge thickening process is that it facilitates further sludge dewatering. Other advantages are high reliability and minimum maintenance requirements.

Limitations of the sludge thickening process are its sensitivity to the flow rate through the thickener and the sludge removal rate. These rates must be low enough not to disturb the thickened sludge.

Operational Factors. Reliability: Reliability is high with proper design and operation. A gravity thickener is designed on the basis of square feet per pound of solids per day, in which the required surface area is related to the solids entering and leaving the unit. Thickener area requirements are also expressed in terms of mass loading, kilograms of solids per square meter per day (lbs/sq ft/day).

Maintainability: Twice a year, a thickener must be shut down for lubrication of the drive mechanisms. Occasionally, water must be pumped back through the system in order to clear sludge pipes.

Solid Waste Aspects: Thickened sludge from a gravity thickening process will usually require further dewatering prior to disposal, incineration, or drying. The clear effluent may be recirculated in part, or it may be subjected to further treatment prior to discharge.

Demonstration Status. Gravity sludge thickeners are used throughout industry to reduce sludge water content to a level where the sludge may be efficiently handled. Further dewatering is usually practiced to minimize costs of hauling the sludge to approved landfill areas.

20. Ion Exchange

Ion exchange is a process in which ions, held by electrostatic forces to charged functional groups on the surface of the ion exchange resin, are exchanged for ions of similar charge from the solution in which the resin is immersed. This is classified as a sorption process because the exchange occurs on the surface of the resin, and the exchanging ion must undergo a phase transfer from solution phase to solid phase. Thus, ionic contaminants in a waste stream can be exchanged for the harmless ions of the resin.

Although the precise technique may vary slightly according to the application involved, a generalized process description follows. The wastewater stream being treated passes through a filter to remove any solids, then flows through a cation exchanger which contains the ion exchange resin. Here, metallic impurities such as copper, iron, and trivalent chromium are retained. The stream then passes through the anion exchanger and its associated resin. Hexavalent chromium (in the form of chromate or dichromate), for example, is retained in this stage. If one pass does not reduce the contaminant levels sufficiently, the stream may then enter another series of exchangers. Many ion exchange systems are equipped with more than one set of exchangers for this reason.

The other major portion of the ion exchange process concerns the regeneration of the resin, which now holds those impurities retained from the waste stream. An ion exchange unit with in-place regeneration is shown in Figure VII-25. Metal ions such as nickel are removed by an acid, cation exchange resin, which is regenerated with hydrochloric or sulfuric acid, replacing the metal ion with one or more hydrogen ions. Anions such as dichromate are removed by a basic anion exchange resin, which is regenerated with sodium hydroxide, replacing the anion with one or more hydroxyl ions. The three principal methods employed by industry for regenerating the spent resin are:

(A) Replacement Service: A regeneration service replaces the spent resin with regenerated resin, and regenerates the spent resin at its own facility. The service then has the problem of treating and disposing of the spent regenerant.

(B) In-Place Regeneration: Some establishments may find it less expensive to do their own regeneration. The spent resin column is shut down for perhaps an hour, and the spent resin is regenerated. This results in one or more waste streams which must be treated in an appropriate manner. Regeneration is performed as the resins require it, usually every few months.

(C) Cyclic Regeneration: In this process, the regeneration of the spent resins takes place within the ion exchange unit itself in alternating cycles with the ion removal process. A regeneration frequency of twice an hour is typical. This very short cycle time permits operation with a very small quantity of resin and with fairly concentrated solutions, resulting in a very compact system. Again, this process varies according to application, but the regeneration cycle generally begins with caustic being pumped through the anion exchanger, carrying out hexavalent chromium, for example, as sodium dichromate. The sodium dichromate stream then passes through a cation exchanger, converting the sodium dichromate to chromic acid. After concentration by evaporation or other means, the chromic acid can be returned to the process line. Meanwhile, the cation exchanger is regenerated with sulfuric acid, resulting in a waste acid stream containing the metallic impurities removed earlier. Flushing the exchangers with water completes the cycle. Thus, the wastewater is purified and, in this example, chromic acid is recovered. The ion exchangers, with newly regenerated resin, then enter the ion removal cycle again.

Application and Performance. The list of pollutants for which the ion exchange system has proven effective includes aluminum, arsenic, cadmium, chromium (hexavalent and trivalent), copper, cyanide, gold, iron, lead, manganese, nickel, selenium, silver, tin, zinc, and others. Thus, it can be applied to a wide variety of industrial concerns. Because of the heavy concentrations of metals in their wastewater, the metal finishing industries utilize ion exchange in several ways. As an end-of-pipe treatment, ion exchange is certainly feasible, but its greatest value is in recovery applications. It is commonly used as an integrated treatment to recover rinse water and process chemicals. Some electroplating facilities use ion exchange to concentrate and purify plating baths. Also, many industrial concerns, including a number of aluminum forming plants, use ion exchange to reduce salt concentrations in incoming water sources.

Ion exchange is highly efficient at recovering metal-bearing solutions. Recovery of chromium, nickel, phosphate solution, and sulfuric acid from anodizing is common. A chromic acid recovery efficiency of 99.5 percent has been demonstrated. Typical data for purification of rinse water are displayed in Table VII-25.

Advantages and Limitations. Ion exchange is a versatile technology applicable to a great many situations. This flexibility, along with its compact nature and performance, makes ion exchange a very effective method of wastewater treatment. However, the resins in these systems can prove to be a limiting factor. The thermal limits of the anion resins, generally in the vicinity of 60°C, could prevent its use in certain situations. Similarly, nitric acid, chromic acid, and hydrogen peroxide can all damage the resins, as will iron, manganese, and copper when present with sufficient concentrations of dissolved oxygen. Removal of a particular trace contaminant may be uneconomical because of the presence of other ionic species that are preferentially removed. The regeneration of the resins presents its own problems. The cost of the regenerative chemicals can be high. In addition, the waste streams originating from the regeneration process are extremely high in pollutant concentrations, although low in volume. These must be further processed for proper disposal.

Operational Factors. Reliability: With the exception of occasional clogging or fouling of the resins, ion exchange has proved to be a highly dependable technology.

Maintainability: Only the normal maintenance of pumps, valves, piping, and other hardware used in the regeneration process is required.

Solid Waste Aspects: Few, if any, solids accumulate within the ion exchangers, and those which do appear are removed by the regeneration process. Proper prior treatment and planning can eliminate solid buildup problems altogether. The brine resulting from regeneration of the ion exchange resin most usually must be treated to remove metals before discharge. This can generate solid waste.

Demonstration Status. All of the ion exchange applications discussed in this section are in commercial use, and industry sources estimate the number of ion exchange units currently in the field at well over 120. The research and development in ion exchange is focusing on improving the quality and efficiency of the resins, rather than new applications. Work is also being done on a continuous regeneration process whereby the resins are contained on a fluid-transfusible belt. The belt passes through a compartmented tank with ion exchange, washing, and regeneration sections. The resins are therefore continually used and regenerated. No such system, however, has been reported beyond the pilot stage.

21. Insoluble Starch Xanthate

Insoluble starch xanthate is essentially an ion exchange medium used to remove dissolved heavy metals from wastewater. The water may then either be reused (recovery application) or discharged (end-of-pipe application). In a commercial electroplating operation, starch xanthate is coated on a filter medium. Rinse water containing dragged out heavy metals is circulated through the filters and then reused for rinsing. The starch-heavy metal complex is disposed of and replaced periodically. Laboratory tests indicate that recovery of metals from the complex is feasible, with regeneration of the starch xanthate. Besides electroplating, starch xanthate is potentially applicable to any other industrial plants where dilute metal wastewater streams are generated. Its present use is limited to one electroplating plant.

22. Peat Adsorption

Peat moss is a complex natural organic material containing lignin and cellulose as major constituents. These constituents, particularly lignin, bear polar functional groups, such as alcohols, aldehydes, ketones, acids, phenolic hydroxides, and ethers, that can be involved in chemical bonding. Because of the polar nature of the material, its adsorption of dissolved solids such as transition metals and polar organic molecules is quite high. These properties have led to the use of peat as an agent for the purification of industrial wastewater.

Peat adsorption is a "polishing" process which can achieve very low effluent concentrations for several pollutants. If the concentrations of pollutants are above 10 mg/l, then peat adsorption must be preceded by pH adjustment for metals precipitation and subsequent clarification. Pretreatment is also required for chromium wastes using ferric chloride and sodium sulfide. The wastewater is then pumped into a large metal chamber called a kier which contains a layer of peat through which the waste stream passes. The water flows to a second kier for further adsorption. The wastewater is then ready for discharge. This system may be automated or manually operated.

Application and Performance. Peat adsorption can be used in aluminum forming plants for removal of residual dissolved metals from clarifier effluent. Peat moss may be used to treat wastewaters containing heavy metals such as mercury, cadmium, zinc, copper, iron, nickel, chromium, and lead, as well as organic matter such as oil, detergents, and dyes. Peat adsorption is currently used commercially at a textile plant, a newsprint facility, and a metal reclamation operation.

Table VII-26 contains performance figures obtained from pilot plant studies. Peat adsorption was preceded by pH adjustment for precipitation and by clarification.

In addition, pilot plant studies have shown that chelated metal wastes, as well as the chelating agents themselves, are removed by contact with peat moss.

Advantages and Limitations. The major advantages of the system include its ability to yield low pollutant concentrations, its broad scope in terms of the pollutants eliminated, and its capacity to accept wide variations of wastewater composition.

Limitations include the cost of purchasing, storing, and disposing of the peat moss; the necessity for regular replacement of the peat may lead to high operation and maintenance costs. Also, the pH adjustment must be altered according to the composition of the waste stream.

Operational Factors. Reliability: The question of long-term reliability is not yet fully answered. Although the manufacturer reports it to be a highly reliable system, operating experience is needed to verify the claim.

Maintainability: The peat moss used in this process soon exhausts its capacity to adsorb pollutants. At that time, the kiers must be opened, the peat removed, and fresh peat placed inside. Although this procedure is easily and quickly accomplished, it must be done at regular intervals, or the system's efficiency drops drastically.

Solid Waste Aspects: After removal from the kier, the spent peat must be eliminated. If incineration is used, precautions should be taken to ensure that those pollutants removed from the water are not released again in the combustion process. Presence of sulfides in the spent peat, for example, will give rise to sulfur dioxide in the fumes from burning. The presence of significant quantities of toxic heavy metals in aluminum forming wastewater will in general preclude incineration of peat used in treating these wastes.

Demonstration Status. Only three facilities currently use commercial adsorption systems in the United States - a textile manufacturer, a newsprint facility, and a metal reclamation firm. No data have been reported showing the use of peat adsorption in aluminum forming plants.

23. Membrane Filtration

Membrane filtration is a treatment system for removing precipitated metals from a wastewater stream. It must therefore be preceded by those treatment techniques which will properly prepare the wastewater for solids removal. Typically, a membrane filtration unit is preceded by pH adjustment or sulfide addition for precipitation of the metals. These steps are followed by the addition of a proprietary chemical reagent which causes the precipitate to be non-gelatinous, easily dewatered, and highly stable. The resulting mixture of pretreated wastewater and reagent is continuously recirculated through a filter module and back into a recirculation tank. The filter module contains tubular membranes. While the reagent-metal hydroxide precipitate mixture flows through the inside of the tubes, the water and any dissolved salts permeate the membrane. When the recirculating slurry reaches a concentration of 10 to 15 percent solids, it is pumped out of the system as sludge.

Application and Performance. Membrane filtration appears to be applicable to any wastewater or process water containing metal ions which can be precipitated using hydroxide, sulfide, or carbonate precipitation. It could function as the primary treatment system, but also might find application as a polishing treatment (after precipitation and settling) to ensure continued compliance with metals limitations. Membrane filtration systems are being used in a number of industrial applications, particularly in the metal finishing area. They have also been used for heavy metals removal in the metal fabrication industry and the paper industry.

The permeate is claimed by one manufacturer to contain less than the effluent concentrations shown in Table VII-27, regardless of the influent concentrations. These claims have been largely substantiated by the analysis of water samples at various plants in various industries.

In the performance predictions for this technology, pollutant concentrations are reduced to the levels shown in Table VII-27 unless lower levels are present in the influent stream.

Advantages and Limitations. A major advantage of the membrane filtration system is that installations can use most of the conventional end-of-pipe systems that may already be in place. Removal efficiencies are claimed to be excellent, even with sudden variation of pollutant input rates; however, the effectiveness of the membrane filtration system can be limited by clogging of the filters. Because pH changes in the waste stream greatly intensify clogging problems, the pH must be carefully monitored and controlled. Clogging can force the shutdown of the system and may interfere with production. In addition, the relatively high capital cost of this system may limit its use.

Operational Factors. Reliability: Membrane filtration has been shown to be a very reliable system, provided that the pH is strictly controlled. Also, surges in the flow rate of the waste stream must be controlled in order to prevent solids from passing through the filter and into the effluent.

Maintainability: The membrane filters must be regularly monitored, and cleaned or replaced as necessary. Depending on the composition of the waste stream and its flow rate, frequent cleaning of the filters may be required. Flushing with hydrochloric acid for six to 24 hours will usually suffice. In addition, the routine maintenance of pumps, valves, and other plumbing is required.

Solid Waste Aspects: When the recirculating reagent-precipitate slurry reaches 10 to 15 percent solids, it is pumped out of the system. It can then be disposed of directly to a landfill or it can undergo a dewatering process. Because this sludge contains toxic metals, it requires proper disposal.

Demonstration Status. There are more than 25 membrane filtration systems presently in use on metal finishing and similar wastewaters. Bench-scale and pilot-studies are being run in an attempt to expand the list of pollutants for which this system is known to be effective. Although there are no data on the use of membrane filtration in aluminum forming plants, the concept has been successfully demonstrated using coil coating plant wastewater.

24. Reverse Osmosis

The process of osmosis involves the passage of a liquid through a semipermeable membrane from a dilute to a more concentrated solution. Reverse osmosis (RO) is an operation in which pressure is applied to the more concentrated solution, forcing the permeate to diffuse through the membrane and into the more dilute solution. This filtering action produces a concentrate and a permeate on opposite sides of the membrane. The concentrate can then be further treated or returned to the original production operation for continued use, while the permeate water can be recycled for use as clean water. Figure VII-26 depicts a reverse osmosis system.

As illustrated in Figure VII-27, there are three basic configurations used in commercially available RO modules: tubular, spiral-wound, and hollow fiber. All of these operate on the physical principle described above, the major difference being their mechanical and structural design characteristics.

The tubular membrane module uses a porous tube with a cellulose acetate membrane-lining. A common tubular module consists of a length of 2.5-cm (1-inch) diameter tube wound on a supporting spool and encased in a plastic shroud. Feed water is driven into the tube under pressures varying from 40 to 55 atm (600 to 800 psi). The permeate passes through the walls of the tube and is collected in a manifold while the concentrate is drained off at the end of the tube. A less widely used tubular RO module uses a straight tube contained in a housing, under the same operating conditions.

Spiral-wound membranes consist of a porous backing sandwiched between two cellulose acetate membrane sheets and bonded along three edges. The fourth edge of the composite sheet is attached to a large permeate collector tube. A spacer screen is then placed on top of the membrane sandwich and the entire stack is rolled around the centrally located tubular permeate collector. The rolled up package is inserted into a pipe able to withstand the high operating pressures employed in this process, up to 55 atm (800 psi) with the spiral-wound module. When the system is operating, the pressurized product water permeates the membrane and flows through the backing material to the central collector tube. The concentrate is drained off at the end of the container pipe and can be reprocessed or sent to further treatment facilities.

The hollow fiber membrane configuration is made up of a bundle of polyamide fibers of approximately 0.0075 cm (0.003 in.) OD and 0.043 cm (0.0017 in.) ID. A commonly used hollow fiber module contains several hundred thousand of the fibers placed in a long tube, wrapped around a flow screen, and rolled into a spiral. The fibers are bent in a U-shape and their ends are supported by an epoxy bond. The hollow fiber unit is operated under 27 atm (400 psi), while the feed water is dispersed from the center of the module through a porous distributor tube. Permeate flows through the membrane to the hollow interiors of the fibers and is collected at the ends of the fibers.

The hollow fiber and spiral-wound modules have a distinct advantage over the tubular system in that they are able to load a very large membrane surface area into a relatively small volume. However, these two membrane types are much more susceptible to fouling than the tubular system, which has a larger flow channel. This characteristic also makes the tubular membrane much easier to clean and regenerate than either the spiral-wound or hollow fiber modules. One manufacturer claims that their helical tubular module can be physically wiped clean by passing a soft porous polyurethane plug under pressure through the module.

Application and Performance. In a number of metal processing plants, the overflow from the first rinse in a countercurrent setup is directed to a reverse osmosis unit, where it is separated into two streams. The concentrated stream contains dragged out chemicals and is returned to the bath to replace the loss of solution due to evaporation and dragout. The dilute stream (the permeate) is routed to the last rinse tank to provide water for the rinsing operation. The rinse flows from the last tank to the first tank and the cycle is complete.

The closed-loop system described above may be supplemented by the addition of a vacuum evaporator after the RO unit in order to further reduce the volume of reverse osmosis concentrate. The evaporated vapor can be condensed and returned to the last rinse tank or sent on for further treatment.

The largest application has been for the recovery of nickel solutions. It has been shown that RO can generally be applied to most acid metal baths with a high degree of performance, providing that the membrane unit is not overtaxed. The limitations most critical here are the allowable pH range and maximum operating pressure for each particular configuration.

Adequate prefiltration is also essential. Only three membrane types are readily available in commercial RO units, and their overwhelming use has been for the recovery of various acid metal baths. For the purpose of calculating performance predictions of this technology, a rejection ratio of 98 percent is assumed for dissolved salts, with 95 percent permeate recovery.

Advantages and Limitations. The major advantage of reverse osmosis for handling process effluents is its ability to concentrate dilute solutions for recovery of salts and chemicals with low power requirements. No latent heat of vaporization or fusion is required for effecting separations; the main energy requirement is for a high pressure pump. It requires relatively little floor space for compact, high capacity units, and it exhibits good recovery and rejection rates for a number of typical process solutions. A limitation of the reverse osmosis process for treatment of process effluents is its limited temperature range for satisfactory operation. For cellulose acetate systems, the preferred limits are 18°C to 30°C (65°F to 85°F); higher temperatures will increase the rate of membrane hydrolysis and reduce system life, while lower temperatures will result in decreased fluxes with no damage to the membrane. Another limitation is inability to handle certain solutions. Strong oxidizing agents, strongly acidic or basic solutions, solvents, and other organic compounds can cause dissolution of the membrane. Poor rejection of some compounds such as borates and low molecular weight organics is another problem. Fouling of membranes by slightly soluble components in solution or colloids has caused failures, and fouling of membranes by feed waters with high levels of suspended solids can be a problem. A final limitation is inability to treat or achieve high concentration with some solutions. Some concentrated solutions may have initial osmotic pressures which are so high that they either exceed available operating pressures or are uneconomical to treat.

Operational Factors. Reliability: This system is very reliable as long as the proper precautions are taken to minimize the chances of fouling or degrading the membrane. Sufficient testing of the waste stream prior to application of an RO system will provide the information needed to ensure a successful application.

Maintainability: Membrane life is estimated to range from six months to three years, depending on the use of the system. Down time for flushing or cleaning is on the order of two hours as often as once each week; a substantial portion of maintenance time must be spent on cleaning any prefilters installed ahead of the reverse osmosis unit.

Solid Waste Aspects: In a closed loop system utilizing RO there is a constant recycle of concentrate and a minimal amount of solid waste. Prefiltration eliminates many solids before they reach the module and helps keep the buildup to a minimum. These solids require proper disposal.

Demonstration Status. There are presently at least one hundred reverse osmosis wastewater applications in a variety of industries. In addition to these, there are 30 to 40 units being used to provide pure process water for several industries. Despite the many types and configurations of membranes, only the spiral-wound cellulose acetate membrane has had widespread success in commercial applications.

25. Sludge Bed Drying

As a waste treatment procedure, sludge bed drying is employed to reduce the water content of a variety of sludges to the point where they are amenable to mechanical collection and removal to a landfill. These beds usually consist of 15 to 45 cm (6 to 18 in.) of sand over a 30 cm (12 in.) deep gravel drain system made up of 3 to 6 mm (1/8 to 1/4 in.) graded gravel overlying drain tiles. Figure VII-32 shows the construction of a drying bed.

Drying beds are usually divided into sectional areas approximately 7.5 meters (25 ft) wide x 30 to 60 meters (100 to 200 ft) long. The partitions may be earth embankments, but more often are made of planks and supporting grooved posts.

To apply liquid sludge to the sand bed, a closed conduit or a pressure pipeline with valved outlets at each sand bed section is often employed. Another method of application is by means of an open channel with appropriately placed side openings which are controlled by slide gates. With either type of delivery system, a concrete splash slab should be provided to receive the falling sludge and prevent erosion of the sand surface.

Where it is necessary to dewater sludge continuously throughout the year regardless of the weather, sludge beds may be covered with a fiberglass reinforced plastic or other roof. Covered drying beds permit a greater volume of sludge drying per year in most climates because of the protection afforded from rain or snow and because of more efficient control of temperature.

Depending on the climate, a combination of open and enclosed beds will provide maximum utilization of the sludge bed drying facilities.

Application and Performance. Sludge drying beds are a means of dewatering sludge from clarifiers and thickeners. They are widely used both in municipal and industrial treatment facilities.

Dewatering of sludge on sand beds occurs by two mechanisms: filtration of water through the bed and evaporation of water as a result of radiation and convection. Filtration is generally complete in one to two days and may result in solids concentrations as high as 15 to 20 percent. The rate of filtration depends on the drainability of the sludge.

The rate of air drying of sludge is related to temperature, relative humidity, and air velocity. Evaporation will proceed at a constant rate to a critical moisture content, then at a falling rate to an equilibrium moisture content. The average evaporation rate for a sludge is about 75 percent of that from a free water surface.

Advantages and Limitations. The main advantage of sludge drying beds over other types of sludge dewatering is the relatively low cost of construction, operation, and maintenance.

Its disadvantages are the large area of land required and long drying times that depend, to a great extent, on climate and weather.

Operational Factors. Reliability: Reliability is high with favorable climatic conditions, proper bed design, and care to avoid excessive or unequal sludge application. If climatic conditions in a given area are not favorable for adequate drying, a cover may be necessary.

Maintainability: Maintenance consists basically of periodic removal of the dried sludge. Sand removed from the drying bed with the sludge must be replaced and the sand layer resurfaced.

The resurfacing of sludge beds is the major expense item in sludge bed maintenance, but there are other areas which may require attention. Underdrains occasionally become clogged and have to be cleaned. Valves or sludge gates that control the flow of sludge to the beds must be kept watertight. Provision for drainage of lines in winter should be provided to prevent damage from freezing. The partitions between beds should be tight so that sludge will not flow from one compartment to another. The outer walls or banks around the beds should also be watertight.

Solid Waste Aspects: The full sludge drying bed must either be abandoned or the collected solids must be removed to a landfill. These solids contain whatever metals or other materials were settled in the clarifier. Metals will be present as hydroxides, oxides, sulfides, or other salts. They have the potential for leaching and contaminating ground water, whatever the location of the semidried solids. Thus the abandoned bed or landfill should include provision for runoff control and leachate monitoring.

Demonstration Status. Sludge beds have been in common use in both municipal and industrial facilities for many years. However, protection of ground water from contamination is not always adequate.

26. Ultrafiltration

Ultrafiltration (UF) is a process which uses semipermeable polymeric membranes to separate emulsified or colloidal materials suspended in a liquid phase by pressurizing the liquid so that it permeates the membrane. The membrane of an ultrafilter forms a molecular screen which retains molecular particles based on their differences in size, shape, and chemical structure. The membrane permits passage of solvents and lower molecular weight molecules. At present, an ultrafilter is capable of removing materials with molecular weights in the range of 1,000 to 100,000 and particles of comparable or larger sizes.

In an ultrafiltration process, the feed solution is pumped through a tubular membrane unit. Water and some low molecular weight materials pass through the membrane under the applied pressure of 10 to 100 psig. Emulsified oil droplets and suspended particles are retained, concentrated, and removed continuously. In contrast to ordinary filtration, retained materials are washed off the membrane filter rather than held by it. Figures VII-29 and VII-34 represent the ultrafiltration process.

Application and Performance. Ultrafiltration has potential application to aluminum forming plants for separation of oils and residual solids from a variety of waste streams. In treating aluminum forming wastewater, its greatest applicability would be as a polishing treatment to remove residual precipitated metals after chemical precipitation and clarification. Successful commercial use, however, has been primarily for separation of emulsified oils from wastewater. Over one hundred such units now operate in the United States, treating emulsified oils from a variety of industrial processes. Capacities of currently operating units range from a few hundred gallons a week to 50,000 gallons per day. Concentration of oily emulsions to 60 percent oil or more are possible. Oil concentrates of 40 percent or more are generally suitable for incineration, and the permeate can be treated further and in some cases recycled back to the process. In this way, it is possible to eliminate contractor removal costs for oil from some oily waste streams.

Table VII-28 indicates ultrafiltration performance (note that UF is not intended to remove dissolved solids). The removal percentages shown are typical, but they can be influenced by pH and other conditions. The permeate or effluent from the ultrafiltration unit is normally of a quality that can be reused in industrial applications or discharged directly. The concentrate from the ultrafiltration unit can be disposed of as any oily or solid waste.

Advantages and Limitations. Ultrafiltration is sometimes an attractive alternative to chemical treatment because of lower capital equipment, installation, and operating costs, very high oil and suspended solids removal, and little required pretreatment. It places a positive barrier between pollutants and effluent which reduces the possibility of extensive pollutant discharge due to operator error or upset in settling and skimming systems. Alkaline values in alkaline cleaning solutions can be recovered and reused in the process.

A limitation of ultrafiltration for treatment of process effluents is its narrow temperature range (18°C to 30°C) for satisfactory operation. Membrane life decreases with higher temperatures, but flux increases at elevated temperatures. Therefore, surface area requirements are a function of temperature and become a tradeoff between initial costs and replacement costs for the membrane. In addition, ultrafiltration cannot handle certain solutions. Strong oxidizing agents, solvents, and other organic compounds can dissolve the membrane. Fouling is sometimes a problem, although the high velocity of the wastewater normally creates enough turbulence to keep fouling at a minimum. Large solids particles can sometimes puncture the membrane and must be removed by gravity settling or filtration prior to the ultrafiltration unit.

Operational Factors. Reliability: The reliaiblity of an ultrafiltration system is dependent on the proper filtration, settling, or other treatment of incoming waste streams to prevent damage to the membrane. Careful pilot studies should be done in each instance to determine necessary pretreatment steps and the exact membrane type to be used. It is advisable to remove any free, floating oil prior to ultrafiltration. Although free oil can be processed, membrane performance may deteriorate.

Maintainability: A limited amount of regular maintenance is required for the pumping system. In addition, membranes must be periodically changed. Maintenance associated with membrane plugging can be reduced by selection of a membrane with optimum physical characteristics and sufficient velocity of the waste stream. It is occassionally necesary to pass a detergent solution occasionally through the system to remove an oil and grease film which accumulates on the membrane. With proper maintenance, membrane life can be greater than 12 months.

Solid Waste Aspects: Ultrafiltration is used primarily to recover solids and liquids. It therefore eliminates solid waste problems when the solids (e.g., paint solids) can be recycled to the process. Otherwise, the stream containing solids must be treated by end-of-pipe equipment. In the most probable applications within the aluminum forming category, the ultrafilter would remove concentrated oily wastes which can be recovered for reuse or used as a fuel.

Demonstration Status. The ultrafiltration process is well developed and commercially available for treatment of wastewater or recovery of certain high molecular weight liquid and solid contaminants. Currently, one plant in the aluminum forming category uses ultrafiltration. This plant ultrafilters its spent rolling oils. Ultrafiltration is well suited for highly concentrated emulsions (e.g., rolling and drawing oils), although it is not suitable for free oil.

27. Vacuum Filtration

In wastewater treatment plants, sludge dewatering by vacuum filtration generally uses cylindrical drum filters. These drums have a filter medium which may be cloth made of natural or synthetic fibers or a wire-mesh fabric. The drum is suspended above and dips into a vat of sludge. As the drum rotates slowly, part of its circumference is subject to an internal vacuum that draws sludge to the filter medium. Water is drawn through the porous filter cake through the drum fabric to a discharge port, and the dewatered sludge, loosened by compressed air, is scraped from the filter mesh. Because the dewatering of sludge on vacuum filters is relatively expensive per kilogram of water removed, the liquid sludge is frequently thickened prior to processing. A vacuum filter is shown in Figure VII-30.

Application and Performance. Vacuum filters are frequently used both in municipal treatment plants and in a wide variety of industries. They are most commonly used in larger facilities, which may have a thickener to double the solids content of clarifier sludge before vacuum filtering. Often a precoat is used to inhibit filter blinding.

The function of vacuum filtration is to reduce the water content of sludge, so that the solids content increases from about 5 percent to between 20 and 30 percent.

Advantages and Limitations. Although the initial cost and area requirement of the vacuum filtration system are higher than those of a centrifuge, the operating cost is lower, and no special provisions for sound and vibration protection need be made. The dewatered sludge from this process is in the form of a moist cake and can be conveniently handled.

Operational Factors. Reliability: Vacuum filter systems have proven reliable at many industrial and municipal treatment facilities. At present, the largest municipal installation is at the West Southwest wastewater treatment plant of Chicago, Illinois, where 96 large filters were installed in 1925, functioned approximately 25 years, and then were replaced with larger units. Original vacuum filters at Minneapolis-St. Paul, Minnesota now have over 28 years of continuous service, and Chicago has some units with similar or greater service life.

Maintainability: Maintenance consists of the cleaning or replacement of the filter media, drainage grids, drainage piping, filter pans, and other parts of the equipment. Experience in a number of vacuum filter plants indicates that maintenance consumes approximately 5 to 15 percent of the total time. If carbonate buildup or other problems are unusually severe, maintenance time may be as high as 20 percent. For this reason, it is desirable to maintain one or more spare units.

If intermittent operation is used, the filter equipment should be drained and washed each time it is taken out of service. An allowance for this wash time must be made in filtering schedules.

Solid Waste Aspects: Vacuum filters generate a solid cake which is usually trucked directly to landfill. All of the metals extracted from the plant wastewater are concentrated in the filter cake as hydroxides, oxides, sulfides, or other salts.

Demonstration Status. Vacuum filtration has been widely used for many years. It is a fully proven, conventional technology for sludge dewatering. At least nine aluminum forming plants report the use of vacuum filtration to dewater their sludge.

IN-PLANT TECHNOLOGY

The intent of in-plant technology for the aluminum forming point source category is to reduce or eliminate the waste load requiring end-of-pipe treatment and thereby improve the efficiency of an existing wastewater treatment system or reduce the requirements of a new treatment system. In-plant technology involves improved rinsing, water conservation, process bath conservation, reduction of dragout, automatic controls, good housekeeping practices, recovery and reuse of process solutions, process modification, and waste treatment. Specific in-plant technologies applicable to this category are discussed below.

28. Process Water Recycle

Recycling of process water is the practice of recirculating water to be used again for the same purpose. An example of recycling process water is the return of casting contact cooling water to the casting process after the water passes through a cooling tower. Two types of recycle are possible--recycle with a bleed stream (blowdown) and total recycle. Total recycle may be prohibited by the presence of dissolved solids. Dissolved solids (e.g., sulfates and chlorides) entering a totally recycled waste stream may precipitate, forming scale if the solubility limits of the dissolved solids are exceeded. A bleed stream may be necessary to prevent maintenance problems (pipe plugging or scaling, etc.) that would be created by the precipitation of dissolved solids. While the volume of bleed required is a function of the amount of dissolved solids in the waste stream, 4 or 5 percent bleed is a common value for a variety of process waste streams in the aluminum forming category. The recycle of process water is currently practiced where it is cost effective, where it is necessary due to water shortage, or where the local permitting authority has required it. Recycle, as compared to the once-through use of process water, is an effective method of conserving water.

Application and Performance. Required hardware necessary for recycle is highly site-specific. Basic items include pumps and piping. Additional materials are necessary if water treatment occurs before the water is recycled. These items will be discussed separately with each unit process. Chemicals may be necessary to control scale buildup, slime, and corrosion problems, especially with recycled cooling water. Maintenance and energy use are limited to that required by the pumps, and solid waste generation is dependent on the type of treatment system in place.

Recycling through cooling towers is the most common practice. One type of application is shown in Figure VII-34. Direct chill casting cooling water is recycled through a cooling tower with a blowdown discharge.

A cooling tower is a device which cools water by bringing the water into contact with air. The water and air flows are directed in such a way as to provide maximum heat transfer. The heat is transferred to air primarily by evaporation (about 75 percent), while the remainder is removed by sensible heat transfer.

Factors influencing the rate of heat transfer and, ultimately, the temperature range of the tower, include water surface area, tower packing and configuration, air flow, and packing height. A large water surface area promotes evaporation, and sensible heat transfer rates are lower in proportion to the water surface area provided. Packing (an internal latticework contact area) is often used to produce small droplets of water which evaporate more easily, thus increasing the total surface area per unit of throughput. For a given water flow, increasing the air flow increases the amount of heat removed by maintaining higher thermodynamic potentials. The packing height in the tower should be high enough so that the air leaving the tower is close to saturation.

A mechanical-draft cooling tower consists of the following major components:

(1) Inlet-water distributor
(2) Packing
(3) Air fans
(4) Inlet-air louvers
(5) Drift or carryover eliminators
(6) Cooled water storage basin.

Advantages and Limitations. Recycle offers economic as well as environmental advantages. Water consumption is reduced and wastewater handling facilities (pumps, pipes, clarifiers, etc.) can thus be sized for smaller flows. By concentrating the pollutants in a much smaller volume (the bleed stream), greater removal efficiencies can be attained by any applied treatment technologies. Recycle may require some treatment such as sedimentation or cooling of water before it is reused.

The ultimate benefit of recycling process water is the reduction in total wastewater discharge and the associated advantages of lower flow streams. A potential problem is the buildup of dissolved solids which could result in scaling. Scaling can usually be controlled by depressing the pH and increasing the bleed flow.

Operational Factors. Reliability and Maintainability: Although the principal construction material in mechanical-draft towers is wood, other materials are used extensively. For long life and minimum maintenance, wood is generally pressure-treated with a preservative. Although the tower structure is usually made of treated redwood, a reasonable amount of treated fir has been used in recent years. Sheathing and louvers are generally made of asbestos cement, and the fan stacks of fiberglass. There is a trend to use fire-resistant extracted PVC as fill which, at little or no increase in cost, offers the advantage of permanent fire-resistant properties.

The major disadvantages of wood are its susceptibility to decay and fire. Steel construction is occasionally used, but not to any great extent. Concrete may be used but has relatively high construction labor costs, although it does offer the advantage of fire protection.

Various chemical additives are used in cooling water systems to control scale, slime, and corrosion. The chemical additives needed depend on the character of the make-up water. All additives have definite limitations and cannot eliminate the need for blowdown. Care should be taken in selecting nontoxic or readily degraded additives, if possible.

Solid Waste Aspects: The only solid waste associated with cooling towers may be removed scale.

Demonstration Status. Many different types of streams in the aluminum forming category are currently recycled. The degree of recycle of these streams is 50 percent or more, most commonly in the 96 to 100 percent range as shown in the water use and wastewater tables in Section V (Tables V-64 and 65, pp. 404 and 406 respectively). Recycling process waters is a viable option for many aluminum forming process wastewaters as shown by the current practices in the industry. This can be seen by examining the amount of recycle in place for two major streams.

The direct chill casting contact cooling water stream is representative of cooling water streams. Of the 61 plants with this stream, 31 recycle more than 96 percent of the flow used, nine recycle between 90 and 96 percent of the flow used, and four plants recycle less than 90 percent of the flow. The remainder of the plants with direct chill casting either did not recycle the cooling water used, or did not supply enough data to calculate the amount recycled. Several of the plants recycling the cooling water stream use cooling towers and in-line oil skimming devices.

All of the plants that use hot rolling oil emulsions and that gave enough information to calculate discharge rates reported using recycle of the emulsion with either a bleed stream or periodic discharge. The recycled flow would often pass through in-line filters to prevent the buildup of solids. Settling tanks and oil skimming devices were also used to separate spent and tramp oils from the emulsion.

Other aluminum forming wastewaters may also be recycled in varying degrees, depending on the required quality of water necessary for a specific operation. Scrubber waters from casting, forging, etch lines, and annealing operations can be recycled because of the low water quality necessary as make-up water. Forging solution heat treatment contact cooling waters can be recycled in a manner similar to that used in direct chill casting contact cooling water. Extrusion die cleaning rinses can be recycled with minimal difficulty in a manner similar to cleaning or etching practices.

29. Process Water Reuse

Reuse of process water is the practice of recirculating water used in one production process for subsequent use in a different production process. An example is the reuse of the rinse water which follows caustic extrusion die cleaning as make-up water for the caustic cleaning solution.

Application and Performance and Demonstration Status. Reuse applications in the aluminum forming category are varied. Some plants reuse extrusion die cleaning rinse water as make-up water for the extrusion die cleaning bath. One plant reuses extrusion press heat treatment contact cooling water and direct chill casting contact cooling water as noncontact cooling water following passage through a cooling tower and an oil skimming device. Primary aluminum plant(s) reuse the contact cooling water from direct chill casting in their reduction scrubbers.

Neat oil rolling, emulsion rolling, drawing, and forging solution heat treatment contact cooling waters have potential as reuse streams in a manner similar to that used for the direct chill casting contact cooling water in the primary aluminum industry. Water may be reused as cleaning or etching rinses following caustic and acidic baths, as casting cooling water, heat treatment solution contact cooling water, or die cleaning rinses.

Advantages and Limitations. Advantages of reuse are similar to the advantages of recycle. Water consumption is reduced and wastewater treatment facilities can be sized for smaller flows. Also, in areas where water shortages occur, reuse is an effective means of conserving water.

Operational Factors. The hardware necessary for reuse of process wastewaters varies, depending on the specific application. The basic elements include pumps and piping. Chemical addition is not usually warranted, unless treatment is required prior to reuse. Maintenance and energy use are limited to that required by the pumps. Solid waste generated is dependent upon the type of treatment used and will be discussed separately with each unit process.

30. Countercurrent Cascade Rinsing

Rinsing is used to dilute the concentration of contaminants adhering to the surface of a workpiece to an acceptable level before the workpiece passes on to the next step in the cleaning or etching operation. The amount of water required to dilute the rinse solution depends on the quantity of chemical drag-in from the upstream rinse or cleaning or etching tank, the allowable concentration of chemicals in the rinse water, and the contacting efficiency between the workpiece and the water.

Process variations such as countercurrent cascade rinsing may cause a decrease in process water use. This technique reduces water use by multiple stage rinsing with a water flow counter to the movement of the workpiece. Clean water contacts the aluminum in the last rinse stage. The water, somewhat more contaminated, is routed stage by stage up the rinsing line. After use in the first rinse stage, the contaminated water is discharged to treatment.

As an example, Figure VII-37 illustrates three rinsing operations, each designed to remove the residual acid in the water on the surface of a workpiece. In Figure VII-37a the piece is dipped into one tank with continuously flowing water. In this case, the acid on the surface of the workpiece is essentially diluted to the required level.

In Figure VII-37b, the first step towards countercurrent operation is taken with the addition of a second tank. The workpiece is now moving in a direction opposite to the rinse water. The piece is rinsed with fresh makeup water prior to moving down the assembly line. However, the fresh water from this final rinse tank is directed to a second tank, where it meets the incoming, more-contaminated workpiece. Fresh makeup water is used to give a final rinse to the article before it moves out of the rinsing section, but the slightly contaminated water is reused to clean the article just coming into the rinsing section. By increasing the number of stages, as shown in Figure VII-37c, further water reduction can be achieved. Theoretically, the amount of water required is the amount of acid being removed by single-stage requirements divided by the highest tolerable concentration in the outgoing rinsewater. This theoretical reduction of water by a countercurrent multistage operation is shown in the curve graph in Figure VII-38. The actual flow reduction obtained is a function of the dragout and the type of contact occurring in the tanks. If reasonably good contact is maintained major reductions in water use are possible.

Application and Performance. As mentioned above, rinse water requirements and the benefits of countercurrent rinsing may be influenced by the volume of solution dragout carried into each rinse stage by the material being rinsed, by the number of rinse stages used, by the initial concentrations of impurities being removed, and by the final product cleanliness required. The influence of these factors is expressed in the rinsing equation which may be stated simply as:

$$Vr = \frac{Co}{Cf}^{\,1/n} \times VD$$

Vr is the flow through each rinse stage.
Co is the concentration of the contaminant(s) in the initial process bath.
Cf is the concentration of the contaminant(s) in the final rinse to give acceptable product cleanliness.
n is the number of rinse stages employed.
VD is the dragout carried into each rinse stage, expressed as a flow.

For a multi-stage rinse, the total volume of rinse wastewater is equal to n times Vr while for a countercurrent rinse the total volume of wastewater discharge equals Vr.

To calculate the benefits of countercurrent rinsing for aluminum forming, it can be assumed that a two-stage countercurrent cascade rinse is installed after the cleaning or etching operations. The mass of aluminum in one square meter of sheet that is 6 mm (0.006 m) in thickness can be calculated using the density of aluminum, 2.64 kkg/m³ (165 lb/cu ft), as follows:

$$= \quad (0.006\ \text{m}) \times (2.64\ \text{kkg/m}^3) = 0.016\ \text{kkg/m}^2 \text{ of sheet}$$

Using the mean cleaning or etching rinse water use from Table V-51 (p. 324), Vr can then be calculated as follows:

$$Vr = 0.016\ \text{kkg/m}^2 \times 32{,}380\ \text{l/kkg} = 518.1\ \text{l/m}^2 \text{ of sheet}$$

Drag-out is solution which remains on the surface of material being rinsed when it is removed from process baths or rinses. Without specific plant data available to determine drag-out, an estimate of rinse water reduction to be achieved with two-stage countercurrent rinsing can be made by assuming a thickness of any process solution film as it is introduced into the rinse tank. If the film on a piece of aluminum sheet is 0.015 mm (0.6 mil) thick, (equivalent to the film on a well-drained vertical surface) then the volume of process solution, VD, carried into the rinse tank on one square meter of sheet will be:

$$VD = (0.015\ \text{mm}) \times \frac{1}{1000}\ \text{m/mm} \times (1000\ \text{l/m}^3)$$

$$= 0.015\ \text{l/m}^2 \text{ of sheet}$$

Let $r = \frac{Co}{Cf}$, then $r^{1/n} = \frac{Vr}{VD}$

For single stage rinsing n = 1, therefore $r = \frac{Vr}{VD}$

and $r = \frac{518.1}{0.015} = 34{,}540$

For a 2-stage countercurrent cascade rinse to obtain the same r, that is the same product cleanliness,

$\frac{Vr}{VD} = r^{1/2}$, therefore $\frac{Vr}{VD} = 185.8$

But VD = 0.015 l/m^2 of sheet; therefore, for 2-stage countercurrent cascade rinsing, Vr is:

$$Vr = 185.8 \times 0.015 = 2.79\ \text{l/m}^2 \text{ of sheet}$$

In this theoretical calculation, a flow reduction of 99.5 percent can be achieved. The actual numbers may vary depending on efficiency of squeegees or air knives, and the rinse ratio desired.

Advantages and Limitations. Significant flow reductions can be achieved by the addition of only one other stage in the rinsing operation, as discussed above. As shown in Figure VII-38 the largest reductions are made by adding the first few stages. Additional rinsing stages cost additional money. The actual number of stages added depends on site-specific layout and operating conditions. With higher costs for water and waste treatment, more stages might be economical. With very low water costs, fewer stages would be economical. In considering retrofit applications, the space available for additional tanks is also important. Many other factors will affect the economics of countercurrent cascade rinsing; an evaluation must be done for each individual plant.

Operational Factors. If the flow from stage to stage can be effected by gravity, either by raising the latter rinse stage tanks or by varying the height of the overflow weirs, countercurrent cascade rinsing is usually quite economical. If, on the other hand, pumps and level controls must be used, then another method, such as spray rinsing, may be more feasible.

Another factor is the need for agitation, which will reduce short circuiting of the flow. Large amounts of short circuiting can reduce the flow reduction attained by adding more stages. In cases where water is cascading in enormous quantities over a workpiece, the high flow usually provides enough agitation. As more staging is applied to reduce the amount of water, the point will be reached where the flow of the water itself is not sufficient to provide agitation. This necessitates either careful baffling of the tanks or additional mechanical agitation.

Demonstration Status. Countercurrent cascade rinsing has been widely used as a flow reduction technique in the metal finishing industry. In aluminum conversion coating lines that are subject to the coil coating limitations, countercurrent cascade rinsing is currently used in order to reduce costs of wastewater treatment systems (through smaller systems) for direct dischargers and to reduce sewer costs for indirect dischargers.

Countercurrent cascade rinsing is currently practiced at two aluminum forming plants. In addition, although not strictly countercurrent rinsing, two plants reuse the rinse water following one etch bath for the rinse of a preceding bath. Based on plant visits to 28 aluminum forming sites, the Agency believes that there is enough available floorspace for the installation of countercurrent cascade rinsing technology at existing sources.

31. Regeneration of Chemical Baths

Regeneration of chemical baths is used to remove contaminants and recover and reuse the bath chemicals, thus minimizing the chemical requirements of the bath while achieving zero discharge.

Application and Performance. Chemical bath regeneration is applicable to recover and reuse chemicals associated with caustic cleaning or etching baths, sulfuric acid etching, conversion coating or anodizing baths, chromic acid etching, conversion coating or anodizing baths, and alkaline cleaning baths.

Some metal salts can be precipitated out of chemical baths by applying a temperature change or shift to the bath. Once the metal salts are precipitated out of solution the chemical properties and utility of the bath can then be restored by adding fresh chemicals. The addition of lime may aid in precipitating dissolved metals by forming carbonates.

Ultrafiltration, previously discussed in this section, can be used to remove oils and particulates from alkaline cleaning baths, allowing the recovery of the water and alkali values to be reused in the make-up of fresh bath rather than treated and discharged.

Ultrafiltration membranes allow only low molecular weight solutes and water to pass through and return to the bath; particulates and oils are held back in a concentrated phase. The concentrated material is then disposed of separately as a solid waste.

Advantages and Limitations. The advantages of bath regeneration are: (1) it reduces the volume of discharge of the chemical bath water; (2) the cleaning or etching operations are made more efficient because the bath can be kept at a relatively constant strength; (3) it results in reduced maintenance labor associated with the bath; and (4) it reduces chemical costs by recovering chemicals and increasing bath life.

Operational Factors. Reliability and Maintainability: Chemical bath regeneration results in lower maintenance labor because the bath life is extended. Regeneration also increases the process reliability in that it eliminates extended periods of downtime to dump the entire bath solution.

It may be necessary to allow baths normally operated at elevated temperatures to cool prior to regeneration. As an example, hot detergent baths will require cooling prior to introducing material into the ultrafiltration membrane.

Solid Waste Aspects: Regeneration of caustic detergent chromic acid and sulfuric acid baths results in the formation of precipitates. These precipitates are collected, dewatered, if necessary, and then disposed of as solid wastes. The aluminum sulfate precipitate resulting from sulfuric acid baths may be commercially marketable. The solid waste aspects of wastewater treatment sludges similar to regeneration sludges are discussed in detail in Section VIII (p. 898).

Demonstration Status. Fifteen aluminum forming plants achieve zero discharge through chemical bath regeneration. These plants achieve this by periodically supplementing the caustic and acid baths. There are commercial processes available for regenerating baths which are patented or claimed confidential. In general, these regeneration processes are based on the fundamental concepts described above.

As discussed previously in this section, ultrafiltration is well developed and commercially available for recovery of high molecular weight liquids and solid contaminants. EPA is not aware of any aluminum forming plants that have applied ultrafiltration for the purpose of regenerating bath materials. There are two aluminum forming plants using ultrafiltration to recover spent lubricant. Performance data for these two systems is shown in Table VII-2. Since alkaline cleaning baths are used to remove these lubricants from the aluminum surface prior to further processing, it is reasonable to assume that ultrafiltration will be equally applicable for separating these same lubricants from alkaline cleaning baths.

32. Process Water Use Reduction

Process water use reduction is the decrease in the amount of process water used as an influent to a production process per unit of production. Section V discusses water use in detail for each aluminum forming operation. A range of water use values taken from the data collection portfolios is presented for each operation. The range of values indicates that some plants use process water more efficiently than others for the same operation. Therefore, some plants can curb their water use; in some cases it may be as simple as turning down a few valves. Noncontact cooling water may replace contact cooling water in some applications; air cooling may also be an alternative to contact cooling water. Conversion to dry air pollution control equipment, discussed further on in this section, is another way to reduce water use.

Many production units in aluminum forming plants operate intermittently or at widely varying production rates. The practice of shutting off process water streams during periods when the unit is inoperative and of adjusting flow rates during periods of low activity can prevent much unnecessary dilution of wastes and reduce the volume of water to be treated and discharged. Water may be shut off and adjusted manually or through automatically controlled valves. Manual adjustment involves minimal capital cost and can be just as reliable in actual practice. Automatic shut off valves are used in some aluminum forming operations to turn off water flows when production units are inactive. Automatic adjustment of flow rates according to production levels requires more sophisticated control systems incorporating temperature or conductivity sensors. Further reduction in water use may be made possible by changes in production techniques and equipment.

The potential for reducing the water use at many aluminum forming facilities is evident in the water use and discharge data presented in Section V of this report. While it may be argued that variations in water flow per unit of production are the necessary result of variations in process conditions, on-site observations indicate that they are more frequently the result of imprecise control of water use. This is confirmed by analysis data from cleaning and etching rinses which show a very wide range of the concentrations of materials removed from product surfaces, and by on-site temperature observations in contact cooling streams.

Reduction of water use in quenches may also significantly reduce discharge volumes. Design of spray quenches to ensure that a high percentage of the water contacts the product and adjustments of make-up water flow rates on quench baths and recirculating spray quench systems to the minimum practical value can significantly reduce effluent volumes.

Pollutant discharges from cleaning and etching operations may also be controlled through the use of drag-out reduction technologies. The volume of water used and discharged from rinsing operations may be substantially reduced without adversely affecting the surface condition of the product processed. Available technologies to achieve these reductions include techniques which limit the amount of material to be removed from product surfaces by rinsing.

On automatic lines which continuously process strip through cleaning and etching operations, measures are normally taken to reduce the amount of process bath solutions which are dragged out with the product into subsequent rinses. The most commonly used means of accomplishing this are through the use of squeegee rolls and air knives. Both mechanisms are found at the point at which the strip exits from the process bath. Squeegee rolls, one situated above the strip and another below, return process solutions as they apply pressure to both sides of the continuously moving strip. Air knives continuously force a jet of air across the width of each side of the strip, forcing solutions to remain in the process tank or chamber. These methods are also used to reduce drag-out from soap and other lubricant tanks which are often found as a final step in automatic strip lines.

Heating the tank containing the process bath can also help reduce drag-out of process solutions in two ways: by decreasing the viscosity and the surface tension of the solution. A lower viscosity allows the liquid to flow more rapidly and therefore drain at a faster rate from the product following application in a process bath, thereby reducing the amount of process solution which dragged out into succeeding rinses. Likewise, a higher temperature will result in lower surface tension in the solution. The amount of work required to overcome the adhesive force between a liquid film and a solid surface is a function of the surface tension of the liquid and the contact angle. Lowering the surface tension reduces the amount of work required to remove the liquid and reduces the edge effect (the bead of liquid adhering to the edges of a product).

Operator performance can have a substantial effect on the amount of drag-out which results from manual dip tank processes. Specifically, proper draining time and techniques can reduce the amount of process solution dragged out into rinses. After dipping the material into the process tank, drag-out can be reduced significantly by simply suspending the product above the process tank while solution drains off. Fifteen to 20 seconds generally seems sufficient to accomplish this. When processing tubing, especially, lowering one end of the load during this drain time allows solution to run off from inside the tubes.

All of the water use reduction techniques discussed in this section may be used at aluminum forming plants to achieve the average production normalized flows at plants which presently discharge excessive amounts of wastewater to treatment.

33. Wastewater Segregation

Application and Performance. The segregation of process waste streams is a valuable control techology and may reduce treatment costs. Individual process waste streams may exhibit very different chemical characteristics, and separating the streams may permit applying the most effective method of treatment or disposal to each stream. Relatively clean waters, such as annealing atmosphere scrubber liquor, should be kept segregated from contaminated streams. Dissimilar streams should not be combined; for example, an oily stream such as direct chill casting contact cooling water should not be combined with a non-oily stream such as cleaning or etching scrubber liquors. Segregation should be based on the type of treatment to be performed for a given pollutant, avoiding oversizing of equipment for treating flows unnecessarily.

Consider two waste streams, one high in chromium and other dissolved solids; the other, a noncontact cooling water without chromium. Significant advantages exist in segregating these two waste streams. If the combined waste streams are being treated to reduce chromium, the resulting high treatment cost will be impractical. Also, if chromium removal by lime precipitation is being practiced, reduced removal efficiencies will result from combining the waste streams due to dilution of chromium concentration. In addition, recycle of the noncontact cooling water will be made difficult by mixing the relatively pure noncontact cooling water with the high dissolved solids stream. Many combinations of waste streams exist throughout the aluminum forming industry where segregation affords distinct advantages.

Equipment necessary for wastewater segregation may include piping, curbing, and possibly pumping. Chemicals are not needed and maintenance and energy use is limited to the pumps.

Advantages. The segregation of stormwater runoff from process-related streams can eliminate overloading of sewer and treatment facilities. Some plants located lower than the surrounding terrain have built flood control dams at higher elevations to minimize the passage of stormwater runoff onto plant property. The use of curbing is an excellent control practice for minimizing the commingling of runoff with process wastewaters. Also, retention ponds should be lined to minimize infiltration of spring water during periods of local flooding and exfiltration of the wastewaters to a nearby aquifer.

34. Lubricating Oil and Deoiling Solvent Recovery

Application and Performance. The recycle of lubricating oils is a common practice in the industry. The degree of recycle is dependent upon any in-line treatment (e.g., filtration to remove aluminum fines and other contaminants), and the useful life of the specific oil in its application. Usually, this involves continuous recirculation of the oil, with losses in the recycle loop from evaporation, oil carried off by the aluminum, and minor loses from in-line treatment. Some plants periodically replace the entire batch of oil once its required properties are depleted. In other cases, a continuous bleed or blowdown stream of oil is withdrawn from the recycle loop to maintain a constant level of oil quality. Fresh make-up oil is added to compensate for the blowdown and other losses, and in-line filtration is used between cycles.

Reuse of oil from spent emulsions used in aluminum rolling and drawing is practiced at some plants. The free oil skimmed from gravity oil and water separation, following emulsion breaking, is valuable. This free oil contains some solids and water which must be removed before the oil can be reused. The traditional treatment involves acidifying the oil in a heated cooker, using steam coils or live steam to heat the oil to a rolling boil. When the oil is sufficiently heated, the steam is shut off and the oil and water are permitted to separate. The collected floating oil layer is suitable for use as supplemental boiler fuel or for some other type of in-house reuse. Other plants choose to sell their oily wastes to oil scavengers, rather than reclaiming the oil themselves. The water phase from this operation is either sent to treatment or, if of a high enough quality, it can be recycled and used to make up fresh emulsion.

Advantages. Some plants collect and recycle rolling oils via mist eliminators. In the rolling process, oils are sprayed as a fine mist on the rollers for cooling and lubricating purposes, and some of this oil becomes airborne and may be lost via exhaust fans or volatilization. With the rising price of oils, it is becoming a more common practice to prevent these losses. Another reason for using hood and mist eliminators is the improvement in the working environment.

Demonstration Status and Operational Factors. Using organic solvents to deoil or degrease aluminum is usually performed prior to sale or subsequent operations such as coating. Recycling the spent solvent can be economically attractive along with its environmental advantages. Some plants (seven out of 30) are known to use distillation units to reclaim spent solvent for recycling. Sludges are normally disposed of by contractor hauling, although some plants may incinerate this waste. Of the 30 plants currently performing aluminum degreasing with organic solvents, two plants are known to discharge part of their spent solvent and oil mixtures to a POTW.

35. Dry Air Pollution Control Devices

Application and Performance. The use of dry air pollution control devices would allow the elimination of waste streams with high pollution potentials. The choice of air pollution control equipment is complicated, and sometimes a wet system is the necessary choice. The important difference between wet and dry devices is that wet devices control gaseous pollutants as well as particulates.

Wet devices may be chosen over dry devices when any of the following factors are found: (1) the particle size is predominantly under 20 microns, (2) flammable particles or gases are to be treated at minimal combustion risk, (3) both vapors and particles are to be removed from the carrier medium, and (4) the gases are corrosive and may damage dry air pollution control devices.

Equipment for dry control of air emissions includes cyclones, dry electrostatic precipitators, fabric filters, and afterburners. These devices remove particulate matter, the first three by entrapment and the afterburners by combustion.

Afterburner use is limited to air emissions consisting mostly of combustible particles. Characteristics of the particulate-laden gas which affect the design and use of a device are gas density, temperature, viscosity, flammability, corrosiveness, toxicity, humidity, and dew point. Particulate characteristics which affect the design and use of a device are particle size, shape, density, resistivity, concentration, and other physiochemical properties.

Melting prior to casting requires wet air pollution control only when chlorine gas is present in the offgases. Dry air pollution control methods with inert gas or salt furnace fluxing have been demonstrated in the industry. It is possible to perform all the metal treatment tasks of removing hydrogen, non-metallic inclusions, and undesirable trace elements and meet the most stringent quality requirements without furnace fluxing, using only in-line metal treatment units. To achieve this, the molten aluminum is treated in the transfer system between the furnace and casting units by flowing the metal through a region of very fine, dense, mixed-gas bubbles generated by a spinning rotor or nozzle. No process wastewater is generated in this operation. A schematic diagram depicting the spinning nozzle refining principle is shown in Figure VII-39. Another similar alternate degassing method is to replace the chlorine-rich degassing agent with a mixture of inert gases and a much lower proportion of chlorine. The technique provides adequate degassing while permitting dry scrubbing.

Scrubbers are used in forging because of the potential fire hazard of baghouses used in this capacity. The oily mist generated in this operation is highly flammable and also tends to plug and bind fabric filters, reducing their efficiency.

Caustic etch and extrusion die cleaning wet air pollution control may be necessary due to the corrosive nature of the gases.

Advantages and Limitations. Proper application of a dry control device can result in particulate removal efficiencies greater than 99 percent by weight for fabric filters, electrostatic precipitators, and afterburners, and up to 95 percent for cyclones.

Common wet air pollution control devices are wet electrostatic precipitators, venturi scrubbers, and packed tower scrubbers. Collection efficiency for gases will depend on the solubility of the contaminant in the scrubbing liquid. Depending on the contaminant removed, collection efficiencies usually approach 99 percent for particles and gases.

Demonstration Status. The aluminum forming industry reports the use of dry air pollution controls for degassing and forging.

36. Good Housekeeping

Good housekeeping and proper equipment maintenance are necessary factors in reducing wastewater loads to treatment systems. Control of accidental spills of oils, process chemicals, and wastewater from washdown and filter cleaning or removal can aid in abating or maintaining the segregation of wastewater streams. Curbed areas should be used to contain or control these wastes.

Leaks in pump casings, process piping, etc., should be minimized to maintain efficient water use. One particular type of leakage which may cause a water pollution problem is the contamination of noncontact cooling water by hydraulic oils, especially if this type of water is discharged without treatment.

Good housekeeping is also important in chemical, solvent, and oil storage areas to preclude a catastrophic failure situation. Storage areas should be isolated from high fire-hazard areas and arranged so that if a fire or explosion occurs, treatment facilities will not be overwhelmed nor excessive groundwater pollution caused by large quantities of chemical-laden fire-protection water.

Bath or rinse waters that drip off the aluminum while it is being transferred from one tank to another (dragout) should be collected and returned to their originating tanks. This can be done with simple drain boards.

A conscientiously applied program of water use reduction can be a very effective method of curtailing unnecessary wastewater flows. Judicious use of washdown water and avoidance of unattended running hoses can significantly reduce water use.

37. Product Substitution

Cyanide containing compounds are proprietary compounds used as additives to quench water to impart surface treatment qualities. Other commercially available compounds which do not contain cyanide can be used for the same purpose. This is demonstrated by the absence of cyanide in the same waste streams from other plants producing the same product. These non-cyanide containing compounds are commercially available and used by other plants in this category; therefore, product substitution would be an effective means for controlling cyanide at an aluminum forming plant.

Table VII-1

pH CONTROL EFFECT ON METALS REMOVAL

	Day 1		Day 2		Day 3	
	In	Out	In	Out	In	Out
pH Range	2.4-3.4	8.5-8.7	1.0-3.0	5.0-6.0	2.0-5.0	6.5-8.1
(mg/1)						
TSS	39	8	16	19	16	7
Copper	312	0.22	120	5.12	107	0.66
Zinc	250	0.31	32.5	25.0	43.8	0.66

Table VII-2

EFFECTIVENESS OF SODIUM HYDROXIDE FOR METALS REMOVAL

	Day 1		Day 2		Day 3	
	In	Out	In	Out	In	Out
pH Range	2.1-2.9	9.0-9.3	2.0-2.4	8.7-9.1	2.0-2.4	8.6-9.1
(mg/l)						
Cr	0.097	0.0	0.057	0.005	0.068	0.005
Cu	0.063	0.018	0.078	0.014	0.053	0.019
Fe	9.24	0.76	15.5	0.92	9.41	0.95
Pb	1.0	0.11	1.36	0.13	1.45	0.11
Mn	0.11	0.06	0.12	0.044	0.11	0.044
Ni	0.077	0.011	0.036	0.009	0.069	0.011
Zn	0.054	0.0	0.12	0.0	0.19	0.037
TSS		13		11		11

Table VII-3

EFFECTIVENESS OF LIME AND SODIUM HYDROXIDE FOR METALS REMOVAL

	Day 1		Day 2		Day 3	
	In	Out	In	Out	In	Out
pH Range	9.2-9.6	8.3-9.8	9.2	7.6-8.1	9.6	7.8-8.2
(mg/l)						
Al	37.3	0.35	38.1	0.35	29.9	0.35
Co	3.92	0.0	4.65	0.0	4.37	0.0
Cu	0.65	0.003	0.63	0.003	0.72	0.003
Fe	137	0.49	110	0.57	208	0.58
Mn	175	0.12	205	0.012	245	0.12
Ni	6.86	0.0	5.84	0.0	5.63	0.0
Se	28.6	0.0	30.2	0.0	27.4	0.0
Ti	143	0.0	125	0.0	115	0.0
Zn	18.5	0.027	16.2	0.044	17.0	0.01
TSS	4,390	9	3,595	13	2,805	13

Table VII-4

THEORETICAL SOLUBILITIES OF HYDROXIDES AND SULFIDES OF SELECTED METALS IN PURE WATER

Metal	Solubility of Metal Ion, mg/l		
	As Hydroxide	As Carbonate	As Sulfide
Cadmium (Cd^{++})	2.3×10^{-5}	1.0×10^{-4}	6.7×10^{-10}
Chromium (Cr^{+++})	8.4×10^{-4}		No precipitate
Cobalt (Co^{++})	2.2×10^{-1}		1.0×10^{-8}
Copper (Cu^{++})	2.2×10^{-2}		5.8×10^{-18}
Iron (Fe^{++})	8.9×10^{-1}		3.4×10^{-5}
Lead (Pb^{++})	2.1	7.0×10^{-3}	3.8×10^{-5}
Manganese (Mn^{++})	1.2		2.1×10^{-3}
Mercury (Hg^{++})	3.9×10^{-4}	3.9×10^{-2}	9.0×10^{-20}
Nickel (Ni^{++})	6.9×10^{-3}	1.9×10^{-1}	6.9×10^{-8}
Silver (Ag^{+})	13.3	2.1×10^{-1}	7.4×10^{-12}
Tin (Sn^{++})	1.1×10^{-4}		3.8×10^{-8}
Zinc (Zn^{++})	1.1	7.0×10^{-4}	2.3×10^{-7}

Table VII-5

SAMPLING DATA FROM SULFIDE PRECIPITATION-SEDIMENTATION SYSTEMS

Treatment	Lime, FeS, Polyelectrolyte, Settle, Filter		Lime, FeS, Polyelectrolyte, Settle, Filter		NaOH, Ferric Chloride, Na_2S, Clarify (1 Stage)	
	In	Out	In	Out	In	Out
pH	5.0-6.8	8-9	7.7	7.38		
(mg/l)						
Cr+6	25.6	<0.014	0.022	<0.020	11.45	<.005
Cr	32.3	<0.04	2.4	<0.1	18.35	<.005
Cu	--	--	--	--	0.029	0.003
Fe	0.52	0.10	108	0.6	--	--
Ni	--	--	0.68	<0.1	--	--
Zn	39.5	<0.07	33.9	<0.1	0.060	0.009

Table VII-6

SULFIDE PRECIPITATION-SEDIMENTATION PERFORMANCE

Parameter	Treated Effluent (mg/l)
Cd	0.01
Cr (Total)	0.05
Cu	0.05
Pb	0.01
Hg	0.03
Ni	0.05
Ag	0.05
Zn	0.01

Table VII-7

FERRITE CO-PRECIPITATION PERFORMANCE

Metal	Influent (mg/l)	Effluent (mg/l)
Mercury	7.4	0.001
Cadmium	240	0.008
Copper	10	0.010
Zinc	18	0.016
Chromium	10	<0.010
Manganese	12	0.007
Nickel	1,000	0.200
Iron	600	0.06
Bismuth	240	0.100
Lead	475	0.010

Table VII-8

CONCENTRATION OF TOTAL CYANIDE (mg/l)

Plant	Method	In	Out
1057	$FeSO_4$	2.57	0.024
		2.42	0.015
		3.28	0.032
33056	$FeSO_4$	0.14	0.09
		0.16	0.09
12052	$ZnSO_4$	0.46	0.14
		0.12	0.06
Mean			0.07

Table VII-9

MULTIMEDIA FILTER PERFORMANCE

Plant ID #	TSS Effluent Concentration, mg/l
06097	0.0, 0.0, 0.5
13924	1.8, 2.2, 5.6, 4.0, 4.0, 3.0, 2.2, 2.8 3.0, 2.0, 5.6, 3.6, 2.4, 3.4
18538	1.0
30172	1.4, 7.0, 1.0
36048	2.1, 2.6, 1.5
Mean	2.61

Table VII-10

PERFORMANCE OF SELECTED SETTLING SYSTEMS

Plant ID	Settling Device	SUSPENDED SOLIDS CONCENTRATION (mg/l)					
		Day 1		Day 2		Day 3	
		In	Out	In	Out	In	Out
01057	Lagoon	54	6	56	6	50	5
09025	Clarifier + Settling Ponds	1,100	9	1,900	12	1,620	5
11058	Clarifier	451	17	--	--	--	--
12075	Settling Pond	284	6	242	10	502	14
19019	Settling Tank	170	1	50	1	--	--
33617	Clarifier & Lagoon	--	--	1,662	16	1,298	4
40063	Clarifier	4,390	9	3,595	12	2,805	13
44062	Clarifier	182	13	118	14	174	23
46050	Settling Tank	295	10	42	10	153	8

Table VII-11

SKIMMING PERFORMANCE

Plant	Skimmer Type	Oil & Grease (mg/l)	
		In	Out
06058	API	224,669	17.9
06058	Belt	19.4	8.3

Table VII-12

TRACE ORGANIC REMOVAL BY SKIMMING
API PLUS BELT SKIMMERS
(From Plant 06058)

	Influent (mg/l)	Effluent (mg/l)
Oil & Grease	225,000	14.6
Chloroform	.023	.007
Methylene Chloride	.013	.012
Naphthalene	2.31	.004
N-nitrosodiphenylamine	59.0	.182
Bis(2-ethylhexyl)phthalate	11.0	.027
Butyl benzyl phthalate	.005	.002
Di-n-octyl phthalate	.019	.002
Anthracene - phenanthrene	16.4	.014
Toluene	.02	.012

Table VII-13

COMBINED METALS DATA EFFLUENT VALUES (mg/l)

	Mean	One-Day Max.	10-Day Avg. Max.	30-Day Avg. Max.
Cd	0.079	0.34	0.15	0.13
Cr	0.084	0.44	0.18	0.12
Cu	0.58	1.90	1.00	0.73
Pb	0.12	0.15	0.13	0.12
Ni	0.74	1.92	1.27	1.00
Zn	0.33	1.46	0.61	0.45
Fe	0.41	1.23	0.63	0.51
Mn	0.21	0.43	0.34	0.27
TSS	12.0	41.0	20.0	15.5

Table VII-14

L&S PERFORMANCE
ADDITIONAL POLLUTANTS

Pollutant	Average Performance (mg/l)
Sb	0.7
As	0.51
Be	0.30
Hg	0.06
Se	0.30
Ag	0.10
Th	0.50
Al	2.24
Co	0.05
F	14.5

Table VII-15

COMBINED METALS DATA SET - UNTREATED WASTEWATER

Pollutant	Min. Conc. (mg/l)	Max. Conc. (mg/l)
Cd	<0.1	3.83
Cr	<0.1	116
Cu	<0.1	108
Pb	<0.1	29.2
Ni	<0.1	27.5
Zn	<0.1	337.
Fe	<0.1	263
Mn	<0.1	5.98
TSS	4.6	4,390

Table VII-16

MAXIMUM POLLUTANT LEVEL IN UNTREATED WASTEWATER ADDITIONAL POLLUTANTS (mg/l)

Pollutant	As & Se	Be	Ag	F
As	4.2	--	--	--
Be	--	10.24	--	--
Cd	<0.1	--	<0.1	<0.1
Cr	0.18	8.60	0.23	22.8
Cu	33.2	1.24	110.5	2.2
Pb	6.5	0.35	11.4	5.35
Ni	--	--	100	0.69
Ag	--	--	4.7	--
Zn	3.62	0.12	1,512	<0.1
F	--	--	--	760
Fe	--	646	--	--
O&G	16.9	--	16	2.8
TSS	352	796	587.8	5.6

Table VII-17

PRECIPITATION-SETTLING-FILTRATION (LS&F) PERFORMANCE
PLANT A

Parameters	No. Points	Range mg/l	Mean ± Std. Dev.	Mean + 2 Std. Dev.
For 1979-Treated Wastewater				
Cr	47	0.015 - 0.13	0.045 ± 0.029	0.10
Cu	12	0.01 - 0.03	0.019 ± 0.006	0.03
Ni	47	0.08 - 0.64	0.22 ± 0.13	0.48
Zn	47	0.08 - 0.53	0.17 ± 0.09	0.35
Fe				
For 1978-Treated Wastewater				
Cr	47	0.01 - 0.07	0.06 ± 0.10	0.26
Cu	28	0.005 - 0.055	0.016 ± 0.010	0.04
Ni	47	0.10 - 0.92	0.20 ± 0.14	0.48
Zn	47	0.08 - 2.35	0.23 ± 0.34	0.91
Fe	21	0.26 - 1.1	0.49 ± 0.18	0.85
Raw Waste				
Cr	5	32.0 - 72.0		
Cu	5	0.08 - 0.45		
Ni	5	1.65 - 20.0		
Zn	5	33.2 - 32.0		
Fe	5	10.0 - 95.0		

Table VII-18

PRECIPITATION-SETTLING-FILTRATION (LS&F) PERFORMANCE
PLANT B

Parameters	No. Points	Range mg/l	Mean ± Std. Dev.	Mean + 2 Std. Dev.
For 1979-Treated Wastewater				
Cr	175	0.0 - 0.40	0.068 ± 0.075	0.22
Cu	176	0.0 - 0.22	0.024 ± 0.021	0.07
Ni	175	0.01 - 1.49	0.219 ± 0.234	0.69
Zn	175	0.01 - 0.66	0.054 ± 0.064	0.18
Fe	174	0.01 - 2.40	0.303 ± 0.398	1.10
TSS	2	1.00 - 1.00		
For 1978-Treated Wastewater				
Cr	144	0.0 - 0.70	0.059 ± 0.088	0.24
Cu	143	0.0 - 0.23	0.017 ± 0.020	0.06
Ni	143	0.0 - 1.03	0.147 ± 0.142	0.43
Zn	131	0.0 - 0.24	0.037 ± 0.034	0.11
Fe	144	0.0 - 1.76	0.200 ± 0.223	0.47
Total 1974-1979-Treated Wastewater				
Cr	1,288	0.0 - 0.56	0.038 ± 0.055	0.15
Cu	1,290	0.0 - 0.23	0.011 ± 0.016	0.04
Ni	1,287	0.0 - 1.88	0.184 ± 0.211	0.60
Zn	1,273	0.0 - 0.66	0.035 ± 0.045	0.13
Fe	1,287	0.0 - 3.15	0.402 ± 0.509	1.42
Raw Waste				
Cr	3	2.80 - 9.15	5.90	
Cu	3	0.09 - 0.27	0.17	
Ni	3	1.61 - 4.89	3.33	
Zn	2	2.35 - 3.39		
Fe	3	3.13 - 35.9	22.4	
TSS	2	177 - 446		

Table VII-19

PRECIPITATION-SETTLING-FILTRATION (LS&F) PERFORMANCE
PLANT C

Parameters	No. Points	Range mg/l	Mean ± Std. Dev.	Mean + 2 Std. Dev.
For Treated Wastewater				
Cd	103	0.010 - 0.500	0.049 ± 0.049	0.147
Zn	103	0.039 - 0.899	0.290 ± 0.131	0.552
TSS	103	0.100 - 5.00	1.244 ± 1.043	3.33
pH	103	7.1 - 7.9	9.2*	
For UnTreated Wastewater				
Cd	103	0.039 - 2.319	0.542 ± 0.381	1.304
Zn	103	0.949 - 29.8	11.009 ± 6.933	24.956
Fe	3	0.107 - 0.46	0.255	
TSS	103	0.80 - 19.6	5.616 ± 2.896	11.408
pH	103	6.8 - 8.2	7.6*	

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*pH value is median of 103 values.

TABLE VII - 20
SUMMARY OF TREATMENT EFFECTIVENESS (mg/1)

Pollutant Parameter		L & S Technology System				LS&F Technology System				Sulfide Precipitation Filtration			
		Mean	One Day Max.	Ten Day Avg.	Thirty Day Avg.	Mean	One Day Max.	Ten Day Avg.	Thirty Day Avg.	Mean	One Day Max.	Ten Day Avg.	Thirty Day Avg.
114	Sb	0.70	2.87	1.28	1.14	0.47	1.93	0.86	0.76				
115	As	0.51	2.09	0.93	0.83	0.34	1.39	0.62	0.55				
117	Be	0.30	1.23	0.55	0.49	0.20	0.82	0.36	0.32				
118	Cd	0.079	0.34	0.15	0.13	0.049	0.20	0.08	0.08	0.01	0.04	0.018	0.016
119	Cr	0.084	0.44	0.18	0.12	0.07	0.37	0.15	0.10	0.08	0.21	0.091	0.081
120	Cu	0.58	1.90	1.00	0.73	0.39	1.28	0.61	0.49	0.05	0.21	0.091	0.081
121	CN	0.07	0.29	0.12	0.11	0.047	0.20	0.08	0.08				
122	Pb	0.12	0.42	0.20	0.16	0.08	0.28	0.13	0.11	0.01	0.04	0.018	0.016
123	Hg	0.06	0.25	0.10	0.10	0.036	0.15	0.06	0.06	0.03	0.13	0.0555	0.049
124	Ni	0.74	1.92	1.27	1.00	0.22	0.55	0.37	0.29	0.05	0.21	0.091	0.081
125	Se	0.30	1.23	0.55	0.49	0.20	0.82	0.37	0.33				
126	Ag	0.10	0.41	0.17	0.16	0.07	0.29	0.12	0.10	0.05	0.21	0.091	0.081
127	Tl	0.50	2.05	0.91	0.81	0.34	1.40	0.62	0.55				
128	Zn	0.33	1.46	0.61	0.45	0.23	1.02	0.42	0.31	0.01	0.04	0.018	0.016
	Al	2.24	6.43	3.20	2.52	1.49	6.11	2.71	2.41				
	Co	0.05	0.21	0.09	0.08	0.034	0.14	0.07	0.06				
	F	14.5	59.5	26.4	23.5		59.5	26.4	23.5				
	Fe	0.41	1.20	0.61	0.50	0.28	1.20	0.61	0.50				
	Mn	0.16	0.68	0.29	0.21	0.14	0.30	0.23	0.19				
	P	4.08	16.7	6.83	6.60	2.72	11.2	4.6	4.4				
	O&G		20.0	12.0	10.0		10.0	10.0	10.0				
	TSS	12.0	41.0	19.5	15.5	2.6	15.0	12.0	10.0				

Table VII-21

CHEMICAL EMULSION BREAKING EFFICIENCIES

Parameter	Concentration (mg/l) Influent	Concentration (mg/l) Effluent	Reference
O&G	6,060	98	Sampling data*
TSS	2,612	46	
O&G	13,000	277	Sampling data+
	18,400	--	
	21,300	189	
TSS	540	121	
	680	59	
	1,060	140	
O&G	2,300	52	Sampling data**
	12,500	27	
	13,800	18	
TSS	1,650	187	
	2,200	153	
	3,470	63	
O&G	7,200	80	Katnick and Pavilcius, 1978++

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*Oil and grease and total suspended solids were taken as grab samples before and after batch emulsion breaking treatment which used alum and polymer on emulsified rolling oil wastewater.

+Oil and grease (grab) and total suspended solids (grab) samples were taken on three consecutive days from emulsified rolling oil wastewater. A commercial demulsifier was used in this batch treatment.

**Oil and grease (grab) and total suspended solids (composite) samples were taken on three consecutive days from emulsified rolling oil wastewater. A commercial demulsifier (polymer) was used in this batch treatment.

++This result is from a full-scale batch chemical treatment system for emulsified oils from a steel rolling mill.

Table VII-22

TREATABILITY RATING OF PRIORITY POLLUTANTS UTILIZING CARBON ADSORPTION

Priority Pollutant	*Removal Rating
1. acenaphthene	H
2. acrolein	L
3. acrylonitrile	L
4. benzene	M
5. benzidine	H
6. carbon tetrachloride (tetrachloromethane)	M
7. chlorobenzene	H
8. 1,2,4-trichlorobenzene	H
9. hexachlorobenzene	H
10. 1,2-dichloroethane	M
11. 1,1,1-trichloroethane	M
12. hexachloroethane	H
13. 1,1-dichloroethane	M
14. 1,1,2-trichloroethane	M
15. 1,1,2,2-tetrachloroethane	H
16. chloroethane	L
17. bis(chloromethyl)ether	-
18. bis(2-chloroethyl)ether	M
19. 2-chloroethyl vinyl ether (mixed)	L
20. 2-chloronaphthalene	H
21. 2,4,6-trichlorophenol	H
22. parachlorometa cresol	H
23. chloroform (trichloromethane)	L
24. 2-chlorophenol	H
25. 1,2-dichlorobenzene	H
26. 1,3-dichlorobenzene	H
27. 1,4-dichlorobenzene	H
28. 3,3'-dichlorobenzidine	H
29. 1,1-dichloroethylene	L
30. 1,2-trans-dichloroethylene	L
31. 2,4-dichlorophenol	H
32. 1,2-dichloropropane	M
33. 1,2-dichloropropylene (1,3,-dichloropropene)	M
34. 2,4-dimethylphenol	H
35. 2,4-dinitrotoluene	H
36. 2,6-dinitrotoluene	H
37. 1,2-diphenylhydrazine	H
38. ethylbenzene	M
39. fluoranthene	H
40. 4-chlorophenyl phenyl ether	H
41. 4-bromophenyl phenyl ether	H
42. bis(2-chloroisopropyl)ether	M
43. bis(2-chloroethoxy)methane	M
44. methylene chloride (dichloromethane)	L
45. methyl chloride (chloromethane)	L
46. methyl bromide (bromomethane)	L
47. bromoform (tribromomethane)	H
48. dichlorobromomethane	M
49. trichlorofluoromethane	M
50. dichlorodifluoromethane	L
51. chlorodibromomethane	M
52. hexachlorobutadiene	H
53. hexachlorocyclopentadiene	H
54. isophorone	H
55. naphthalene	H
56. nitrobenzene	H
57. 2-nitrophenol	H
58. 4-nitrophenol	H
59. 2,4-dinitrophenol	H
60. 4,6-dinitro-o-cresol	H
61. N-nitrosodimethylamine	M
62. N-nitrosodiphenylamine	H
63. N-nitrosodi-n-propylamine	M
64. pentachlorophenol	H
65. phenol	M
66. bis(2-ethylhexyl)phthalate	H
67. butyl benzyl phthalate	H
68. di-n-butyl phthalate	H
69. di-n-octyl phthalate	H
70. diethyl phthalate	H
71. dimethyl phthalate	H
72. 1,2-benzanthracene (benzo (a)anthracene)	H
73. benzo(a)pyrene (3,4-benzo-pyrene)	H
74. 3,4-benzofluoranthene (benzo(b)fluoranthene)	H
75. 11,12-benzofluoranthene (benzo(k)fluoranthene)	H
76. chrysene	H
77. acenaphthylene	H
78. anthracene	H
79. 1,12-benzoperylene (benzo (ghi)-perylene)	H
80. fluorene	H
81. phenanthrene	H
82. 1,2,5,6-dibenzathracene (dibenzo (a,h) anthracene)	H
83. indeno (1,2,3-cd) pyrene (2,3-o-phenylene pyrene)	H
84. pyrene	-
85. tetrachloroethylene	M
86. toluene	M
87. trichloroethylene	L
88. vinyl chloride (chloroethylene)	L
106. PCB-1242 (Arochlor 1242)	H
107. PCB-1254 (Arochlor 1254)	H
108. PCB-1221 (Arochlor 1221)	H
109. PCB-1332 (Arochlor 1232)	H
110. PCB-1248 (Arochlor 1248)	H
111. PCB-1260 (Arochlor 1260)	H
112. PCB-1016 (Arochlor 1016)	H

* NOTE: Explanation of Removal RAtings

Category H (high removal)
adsorbs at levels $\geq$ 100 mg/g carbon at C_f = 10 mg/l
adsorbs at levels $\geq$ 100 mg/g carbon at C_f < 1.0 mg/l

Category M (moderate removal)
adsorbs at levels $\geq$ 100 mg/g carbon at C_f = 10 mg/l
adsorbs at levels $\leq$ 100 mg/g carbon at C_f < 1.0 mg/l

Category L (low removal)
adsorbs at levels < 100 mg/g carbon at C_f = 10 mg/l
adsorbs at levels < 10 mg/g carbon at C_f < 1.0 mg/l

C_f = final concentrations of priority pollutant at equilibrium

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Table VII-23

CLASSES OF ORGANIC COMPOUNDS ADSORBED ON CARBON

Organic Chemical Class	Examples of Chemical Class
Aromatic Hydrocarbons	benzene, toluene, xylene
Polynuclear Aromatics	naphthalene, anthracene bephenyls
Chlorinated Aromatics	chlorobenzene, polychlorinated biphenyls, aldrin, endrin, toxaphene, DDT
Phenolics	phenol, cresol, resorcenol and polyphenyls
Chlorinated Phenolics	trichlorophenol, pentachlorophenol
High Molecular Weight Aliphatic and Branch Chain Hydrocarbons	gasoline, kerosine
Chlorinated Aliphatic Hydrocarbons	carbon tetrachloride, perchloroethylene
High Molecular Weight Aliphatic Acids and Aromatic Acids	tar acids, benzoic acid
High Molecular Weight Aliphatic Amines and Aromatic Amines	aniline, toluene diamine
High Molecular Weight Ketones, Esters, Ethers and Alcohols	hydroquinone, polyethylene glycol
Surfactants	alkyl benzene sulfonates
Soluble Organic Dyes	melkylene blue, Indigo carmine

High Molecular Weight includes compounds in the broad range of from 4 to 20 carbon atoms.

Table VII-24

ION EXCHANGE PERFORMANCE
(All Values mg/l)

Parameter	Plant A Prior to Purification	Plant A After Purification	Plant B Prior to Purification	Plant B After Purification
Al	5.6	0.20	--	--
Cd	5.7	0.00	--	--
Cr+3	3.1	0.01	--	--
Cr+6	7.1	0.01	--	--
Cu	4.5	0.09	43.0	0.10
CN	9.8	0.04	3.40	0.09
Au	--	--	2.30	0.10
Fe	7.4	0.01	--	--
Pb	--	--	1.70	0.01
Mn	4.4	0.00	--	--
Ni	6.2	0.00	1.60	0.01
Ag	1.5	0.00	9.10	0.01
SO_4	--	--	210.00	2.00
Sn	1.7	0.00	1.10	0.10
Zn	14.8	0.40	--	--

Table VII-25

PEAT ADSORPTION PERFORMANCE

Pollutant	Influent (mg/l)	Effluent (mg/l)
Cr+6	35,000	0.04
Cu	250	0.24
CN	36.0	0.7
Pb	20.0	0.025
Hg	1.0	0.02
Ni	2.5	0.07
Ag	1.0	0.05
Sb	2.5	0.9
Zn	1.5	0.25

Table VII-26

MEMBRANE FILTRATION SYSTEM EFFLUENT

Specific Metal	Manufacturer's Guarantee	Plant 19066		Plant 31022		Predicted Perfor-mance
		In	Out	In	Out	
Al	0.5	--	--	--	--	--
Cr, (+6)	0.02	0.46	0.01	5.25	<0.005	--
Cr (T)	0.03	4.13	0.018	98.4	0.057	0.05
Cu	0.1	18.8	0.043	8.00	0.222	0.20
Fe	0.1	288	0.3	21.1	0.263	0.30
Pb	0.05	0.652	0.01	0.288	0.01	0.05
CN	0.02	<0.005	<0.005	<0.005	<0.005	0.02
Ni	0.1	9.56	0.017	194	0.352	0.40
Zn	0.1	2.09	0.046	5.00	0.051	0.10
TSS	--	632	0.1	13.0	8.0	1.0

Table VII-27

ULTRAFILTRATION PERFORMANCE

Parameter	Feed (mg/l)	Permeate (mg/l)
Oil (freon extractable)	95	22*
	1,540	52*
	1,230	4
COD	8,920	148
TSS	791	19*
	1,262	26*
	5,676	13*
	1,380	13
Total Solids	2,900	296

---

*From samples at aluminum forming Plant B.

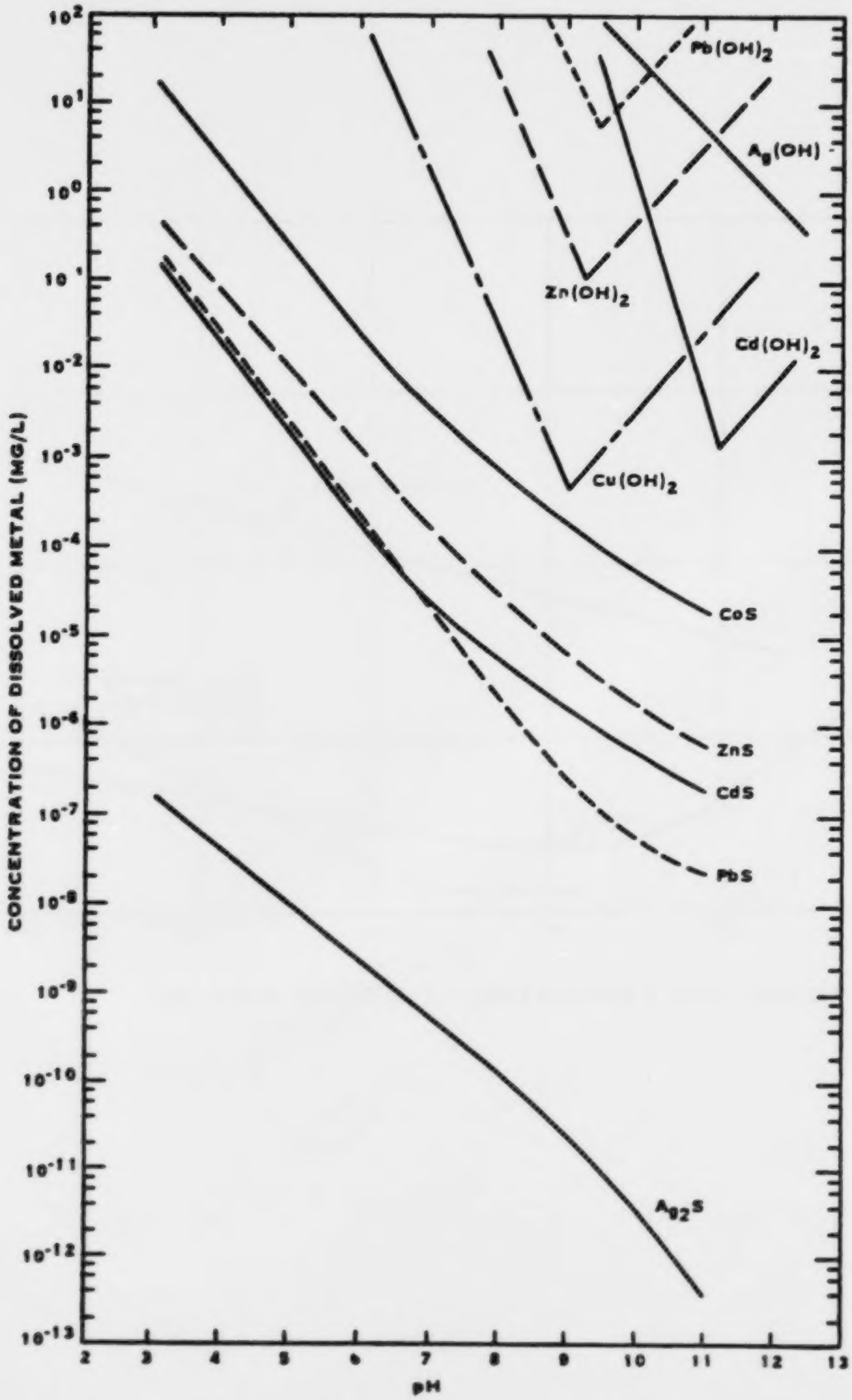


FIGURE VII-1. COMPARATIVE SOLUBILITIES OF METAL HYDROXIDES AND SULFIDE AS A FUNCTION OF pH

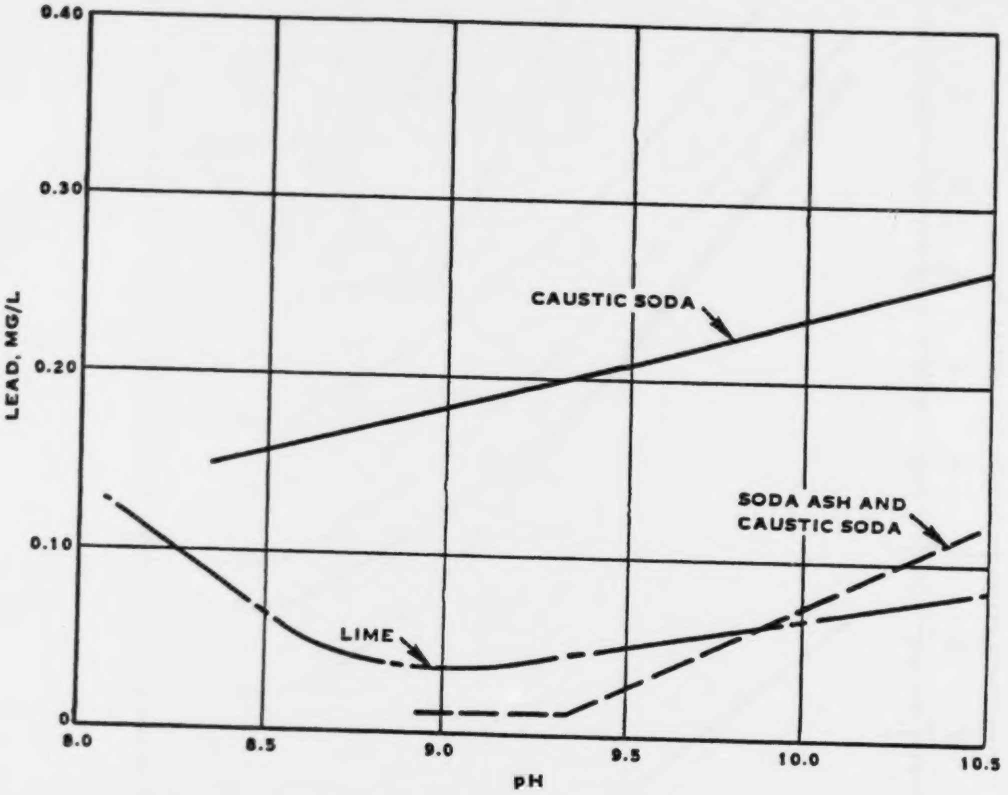


FIGURE VII-2. LEAD SOLUBILITY IN THREE ALKALIES

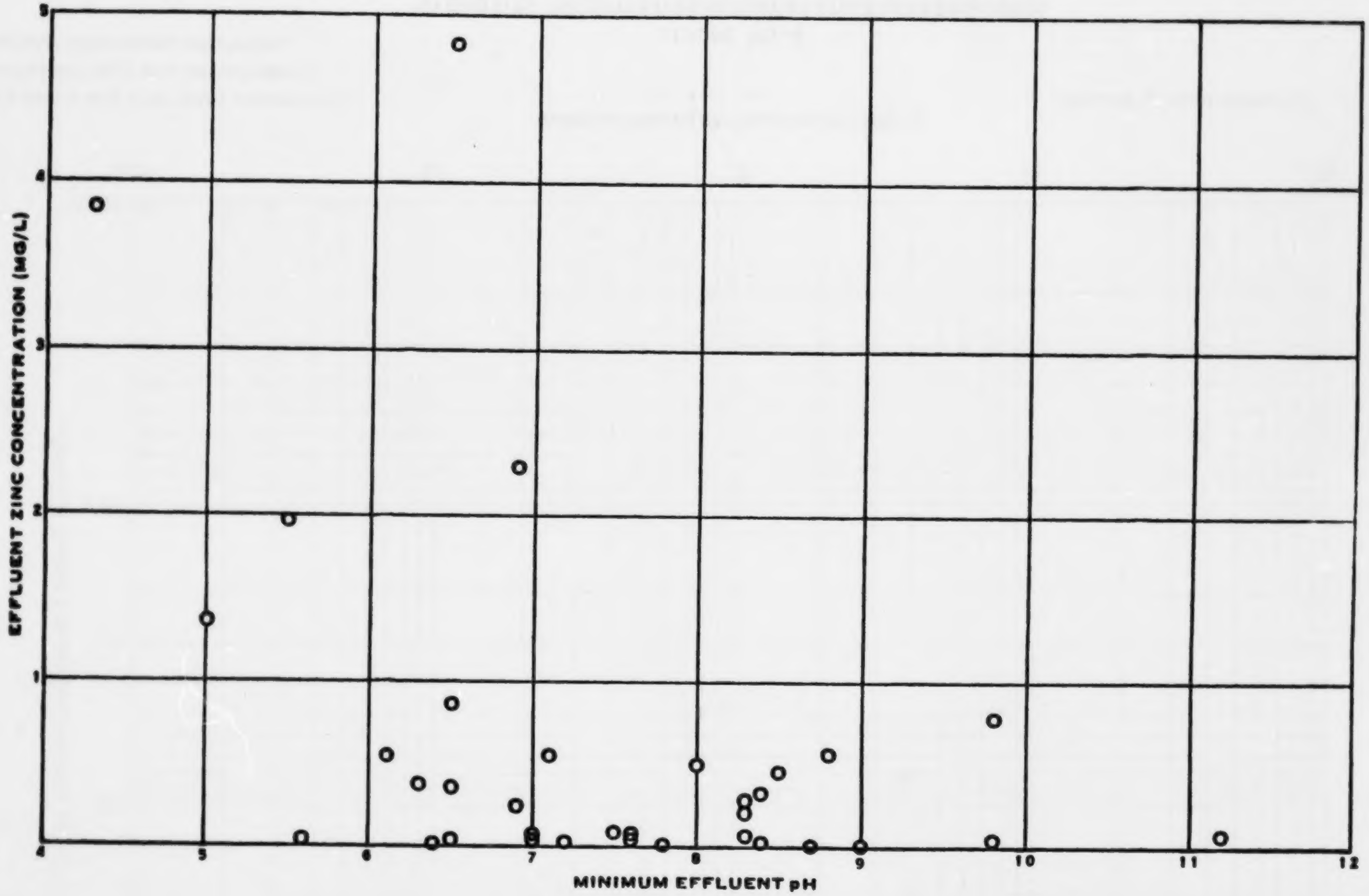
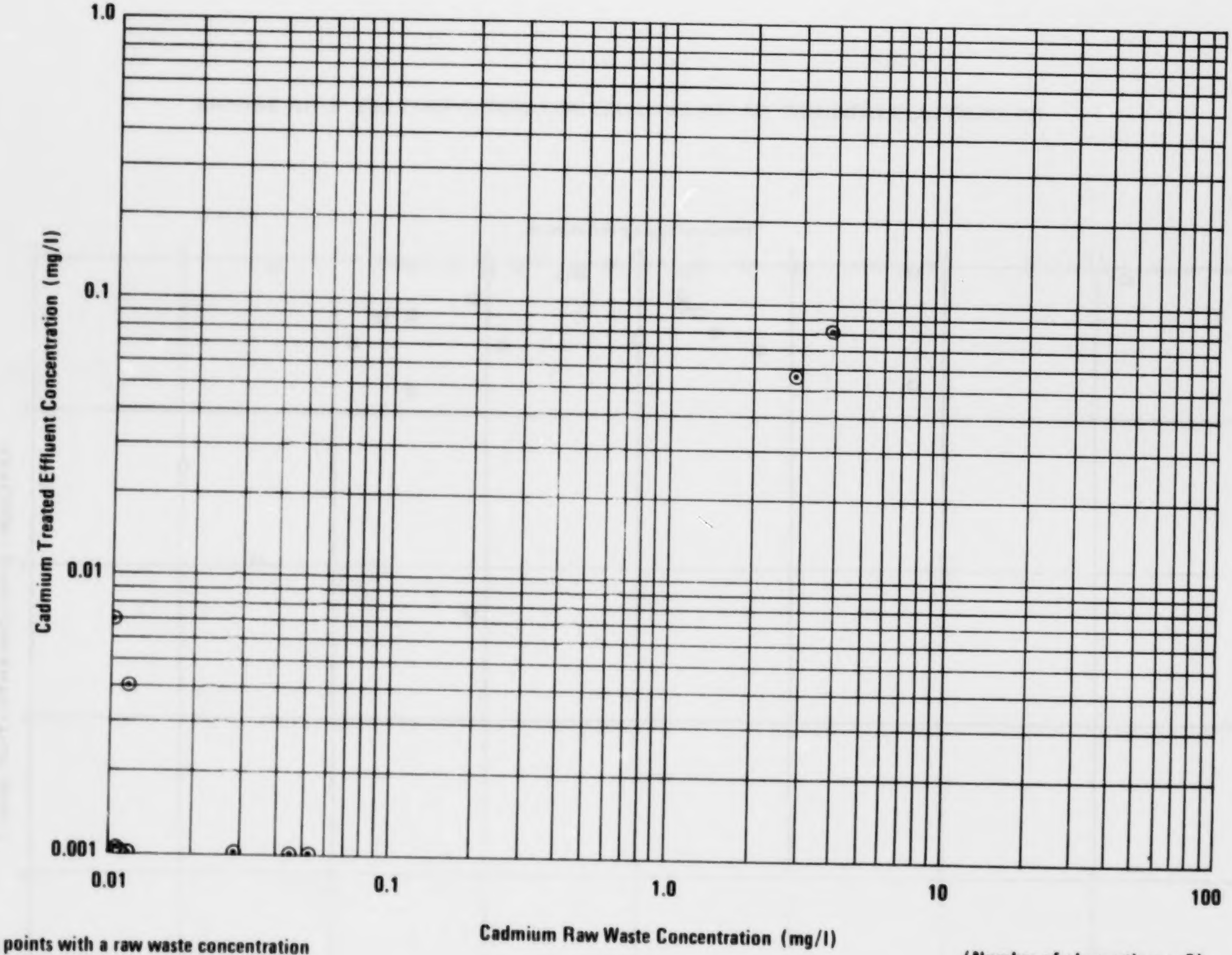


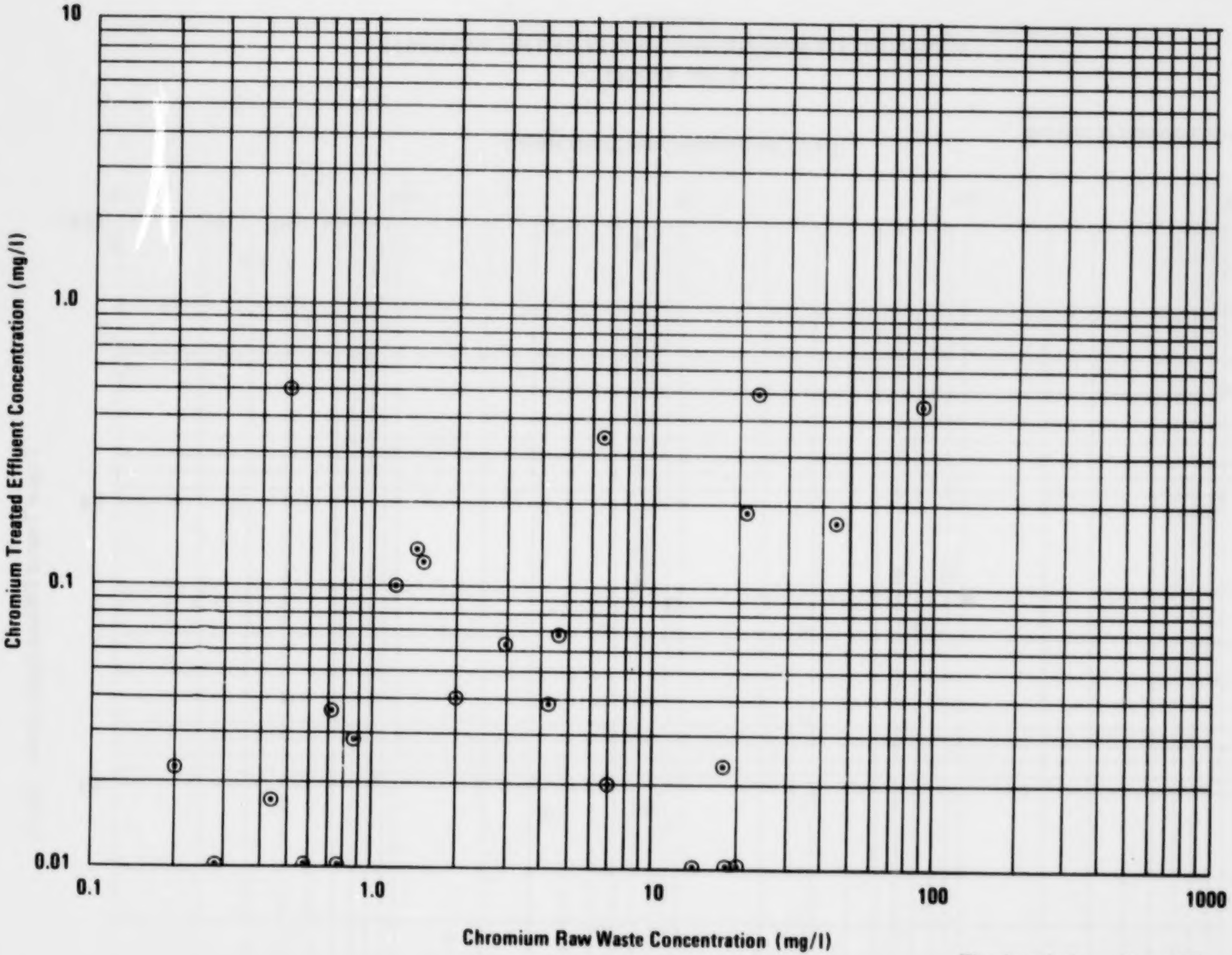
FIGURE VII-3. EFFLUENT ZINC CONCENTRATION VS. MINIMUM EFFLUENT pH



Data points with a raw waste concentration less than 0.1 mg/l were not included in treatment effectiveness calculations.

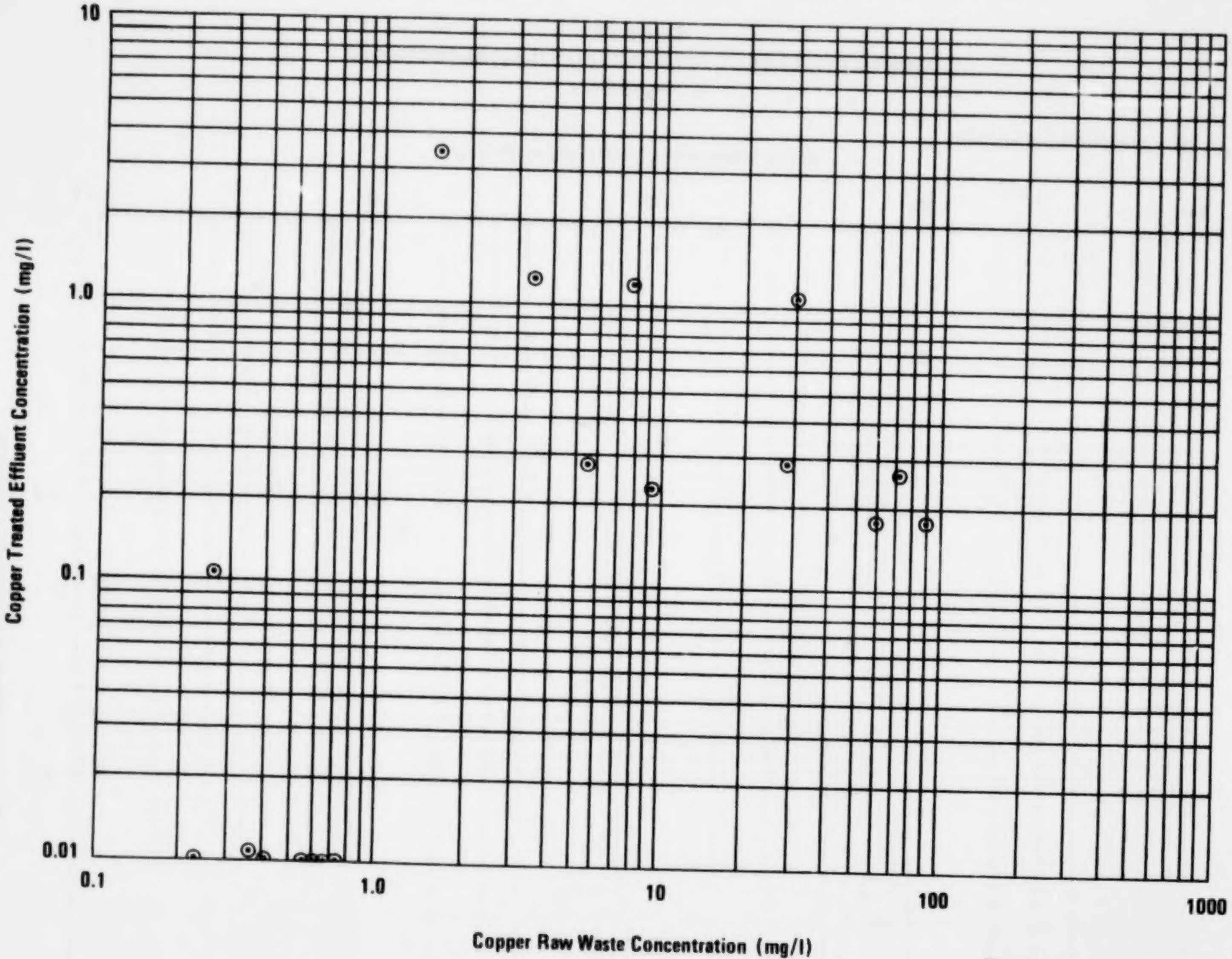
(Number of observations = 2)

FIGURE VII-4
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
CADMIUM



(Number of observations = 25)

FIGURE VII-5
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
CHROMIUM



(Number of observations = 18)

FIGURE VII-6
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
COPPER

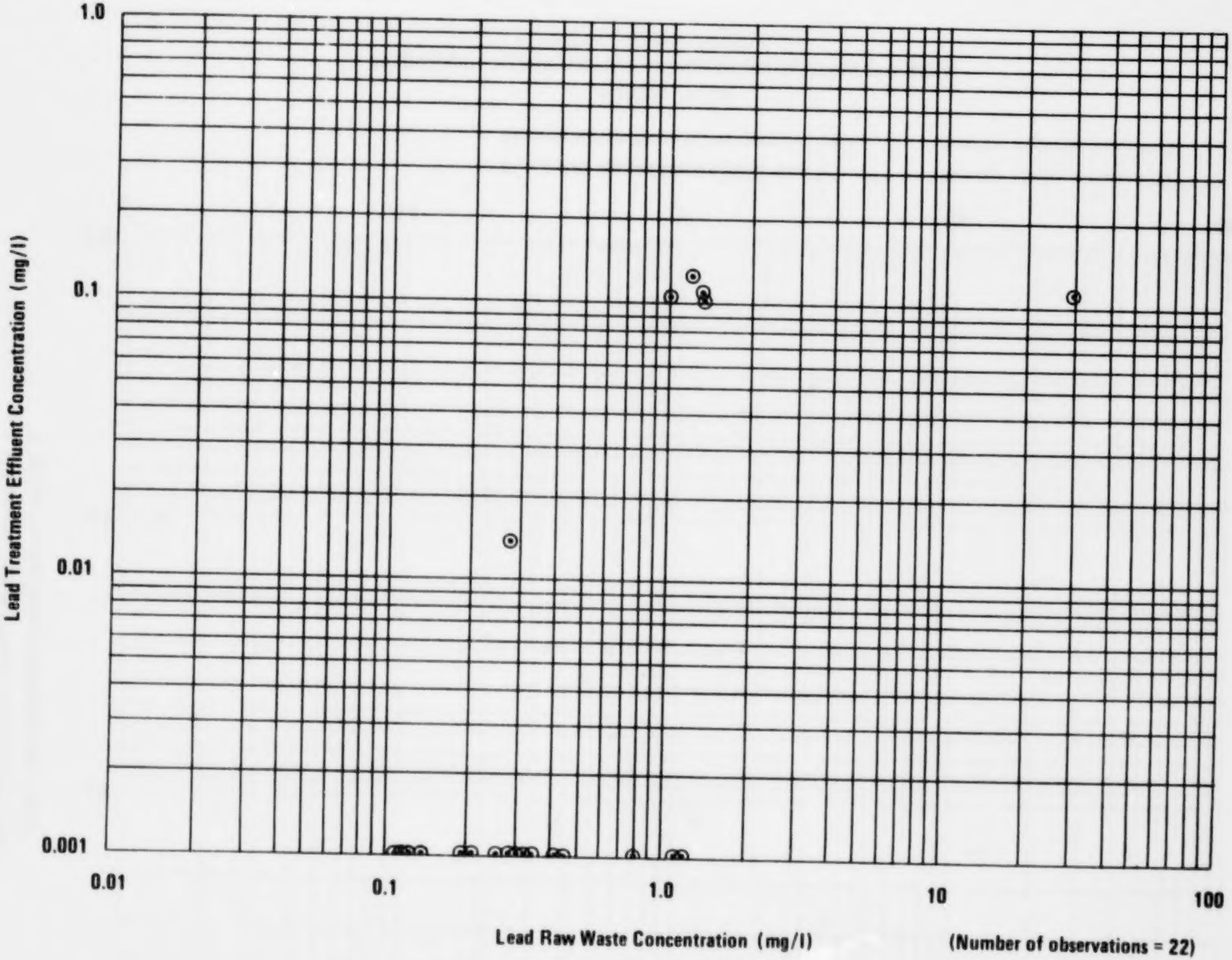
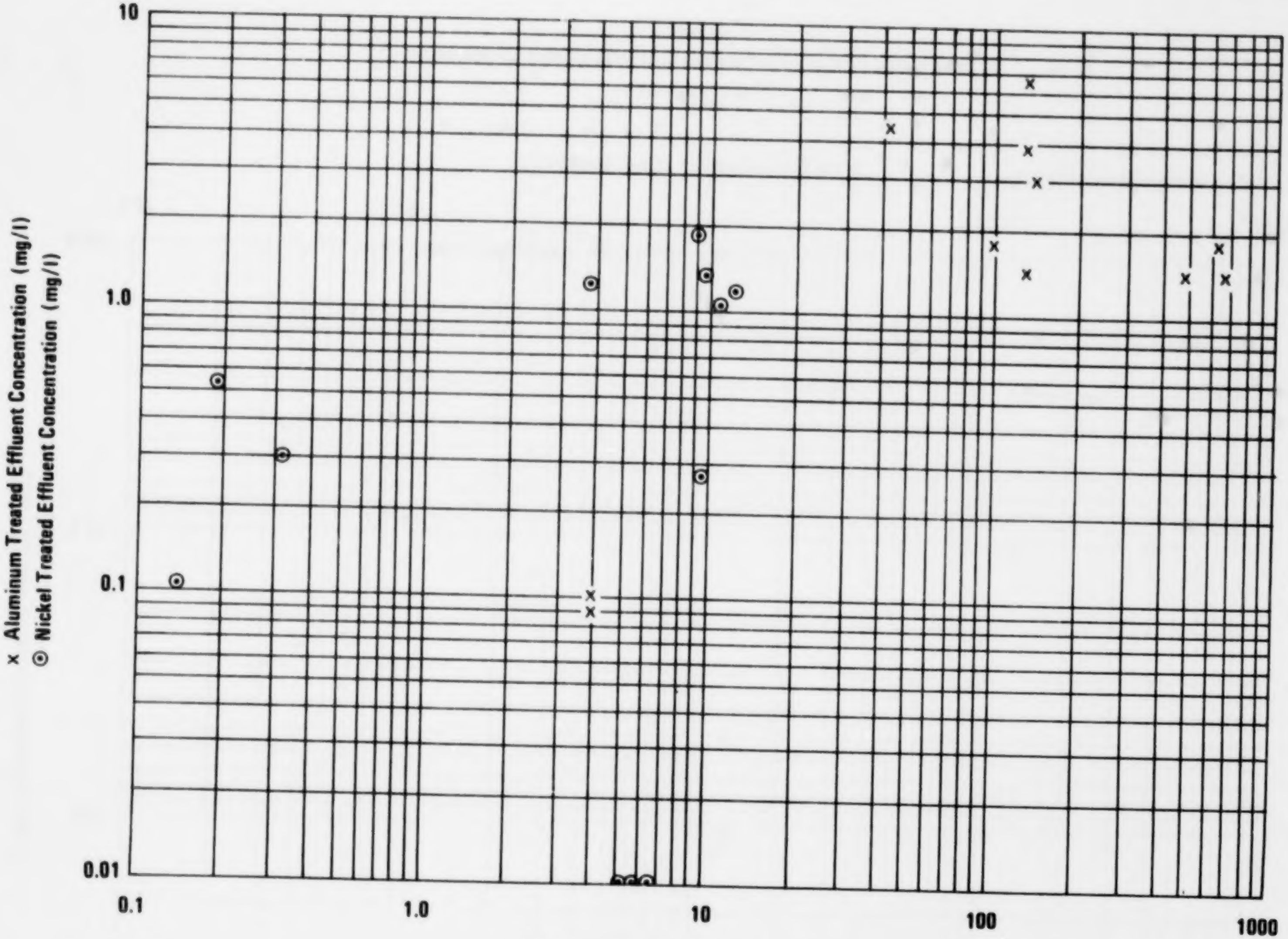
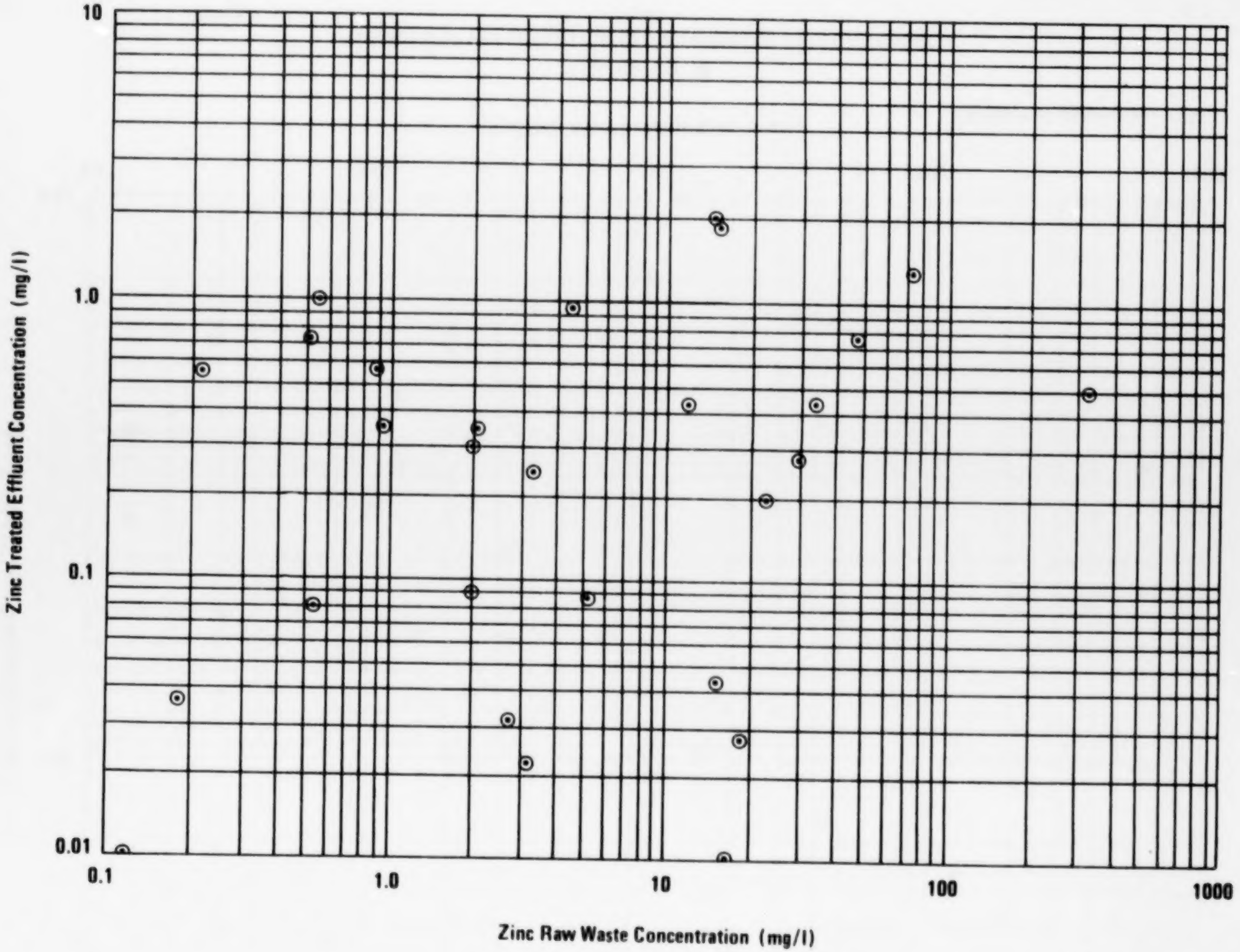


FIGURE VII-7
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
LEAD



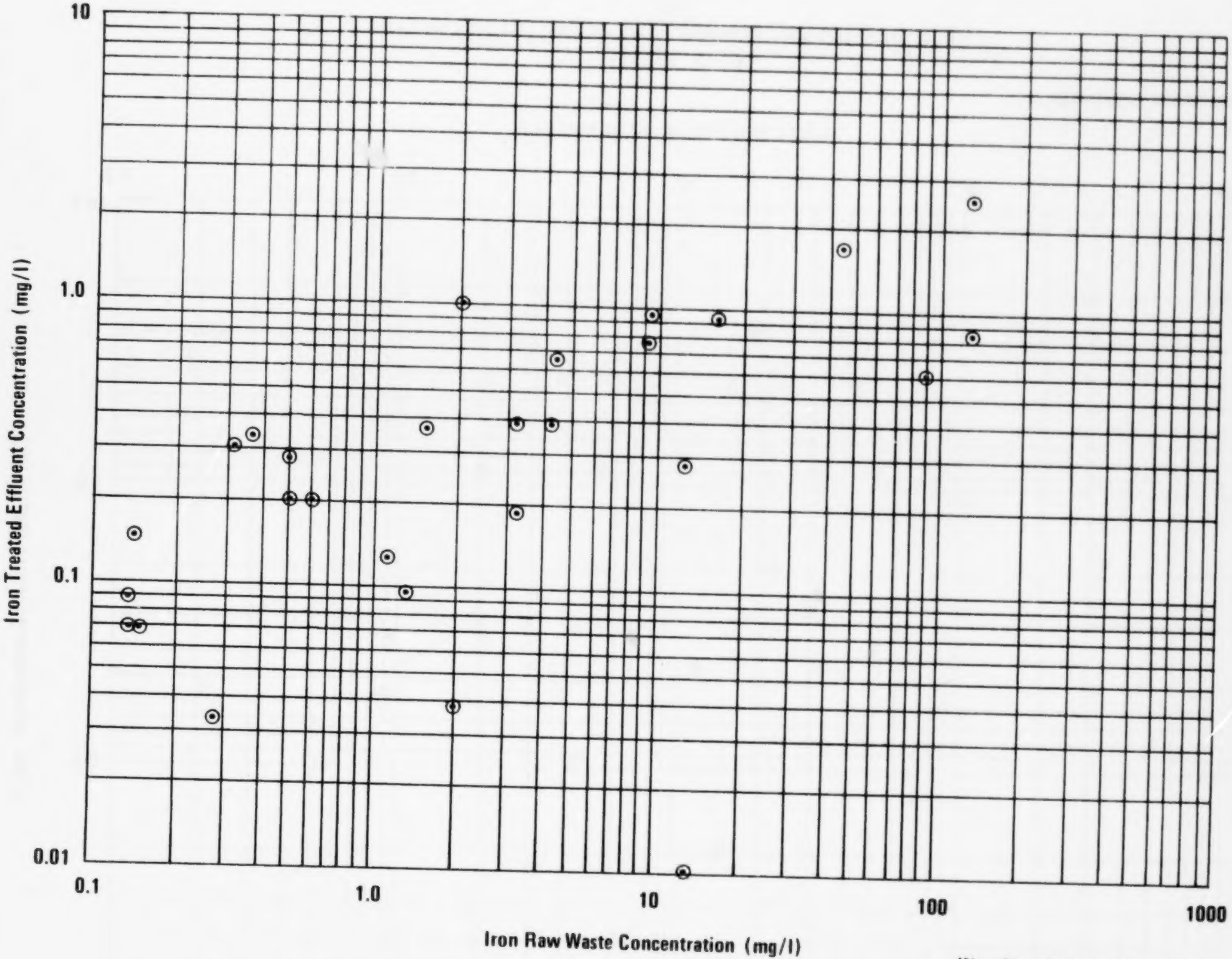
⊙ Nickel Raw Waste Concentration (mg/l) (Number of observations = 12)
× Aluminum Raw Waste Concentration (mg/l) (Number of observations = 11)

FIGURE VII-8
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
NICKEL AND ALUMINUM



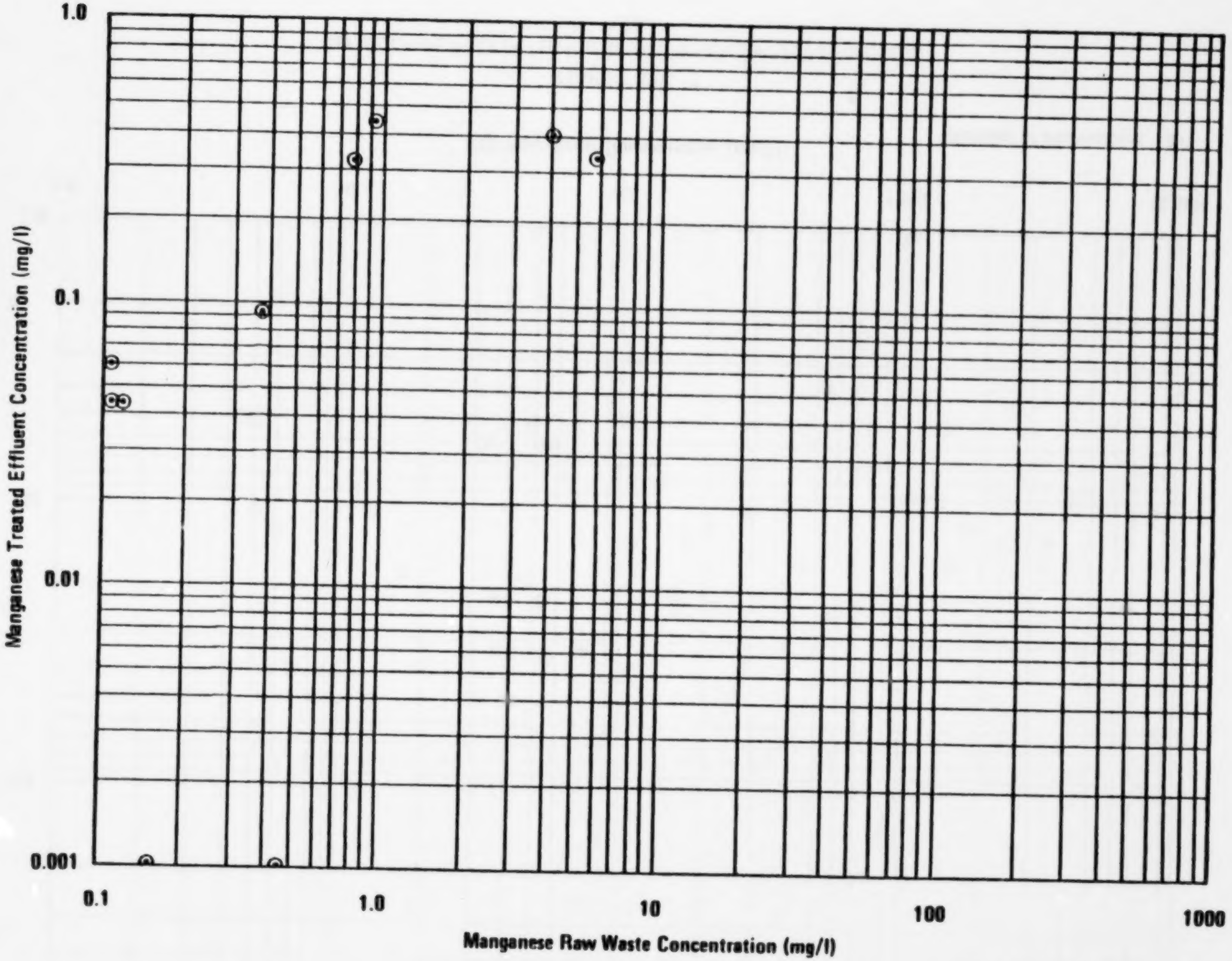
(Number of observations = 28)

FIGURE VII-9
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
ZINC



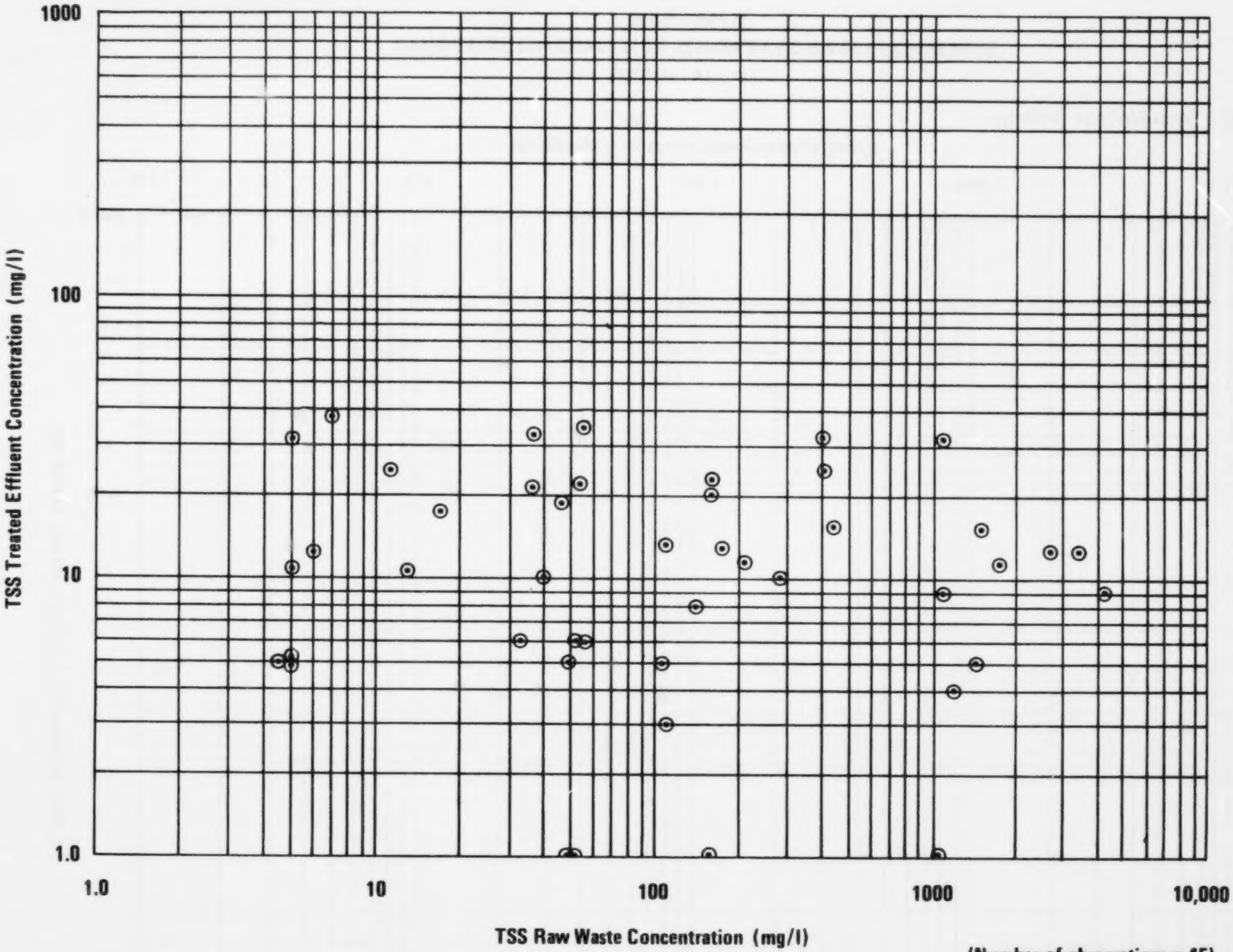
(Number of observations = 28)

FIGURE VII-10
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
IRON



(Number of observations = 10)

FIGURE VII – 11
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
MANGANESE



(Number of observations = 45)

FIGURE VII-12
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
TSS

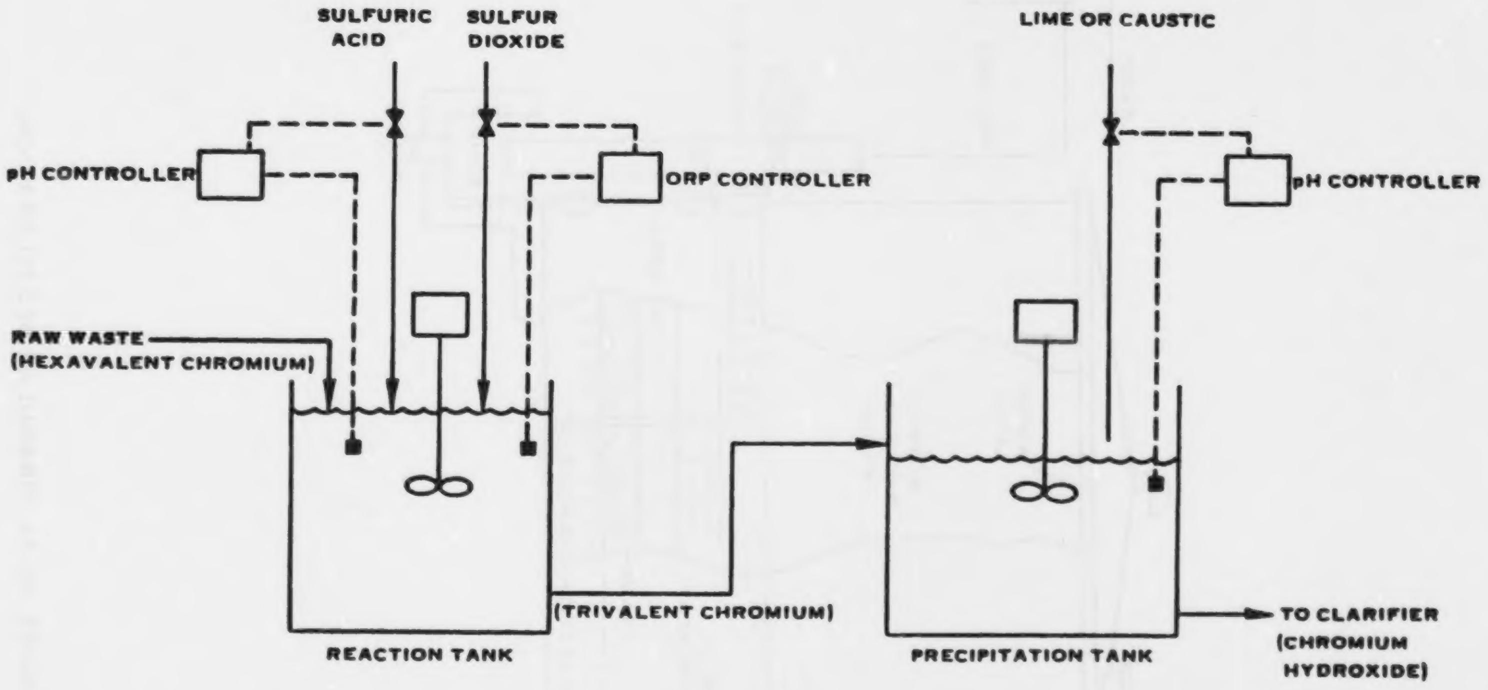


FIGURE VII-13. HEXAVALENT CHROMIUM REDUCTION WITH SULFUR DIOXIDE

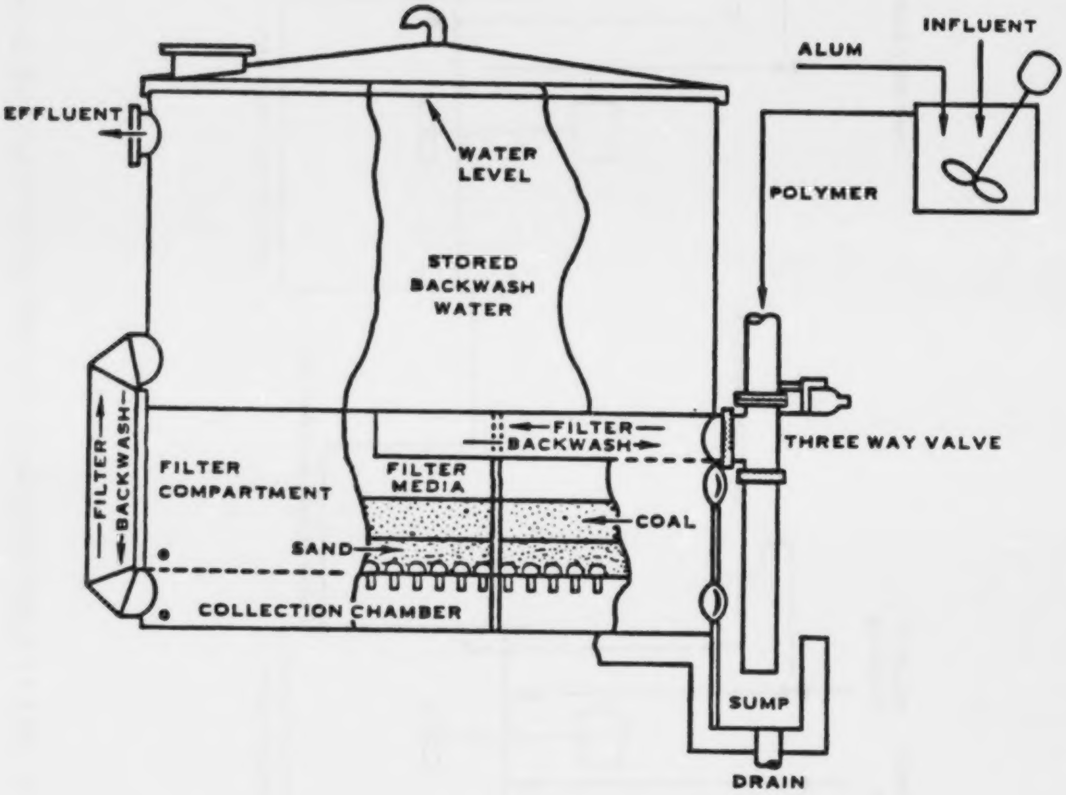


FIGURE VII-14. GRANULAR BED FILTRATION

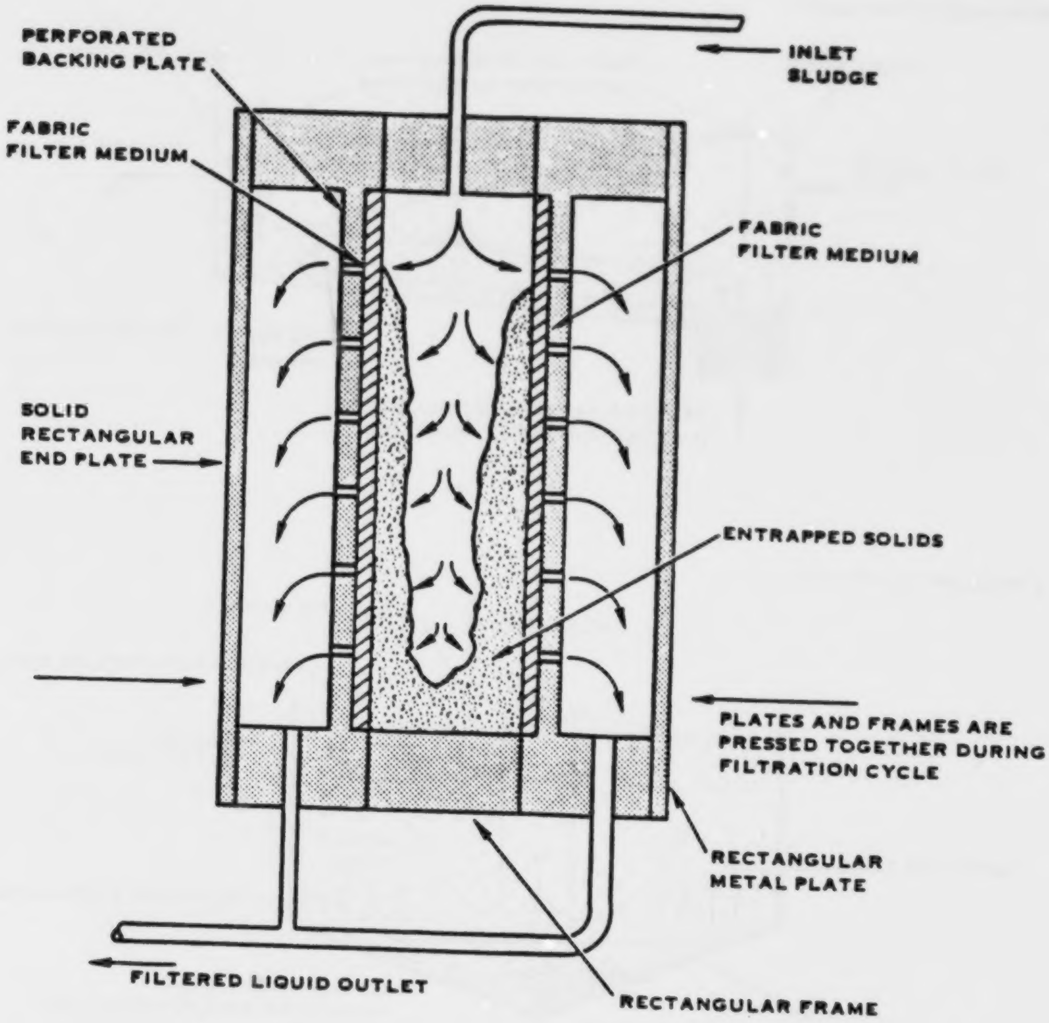


FIGURE VII-15. PRESSURE FILTRATION

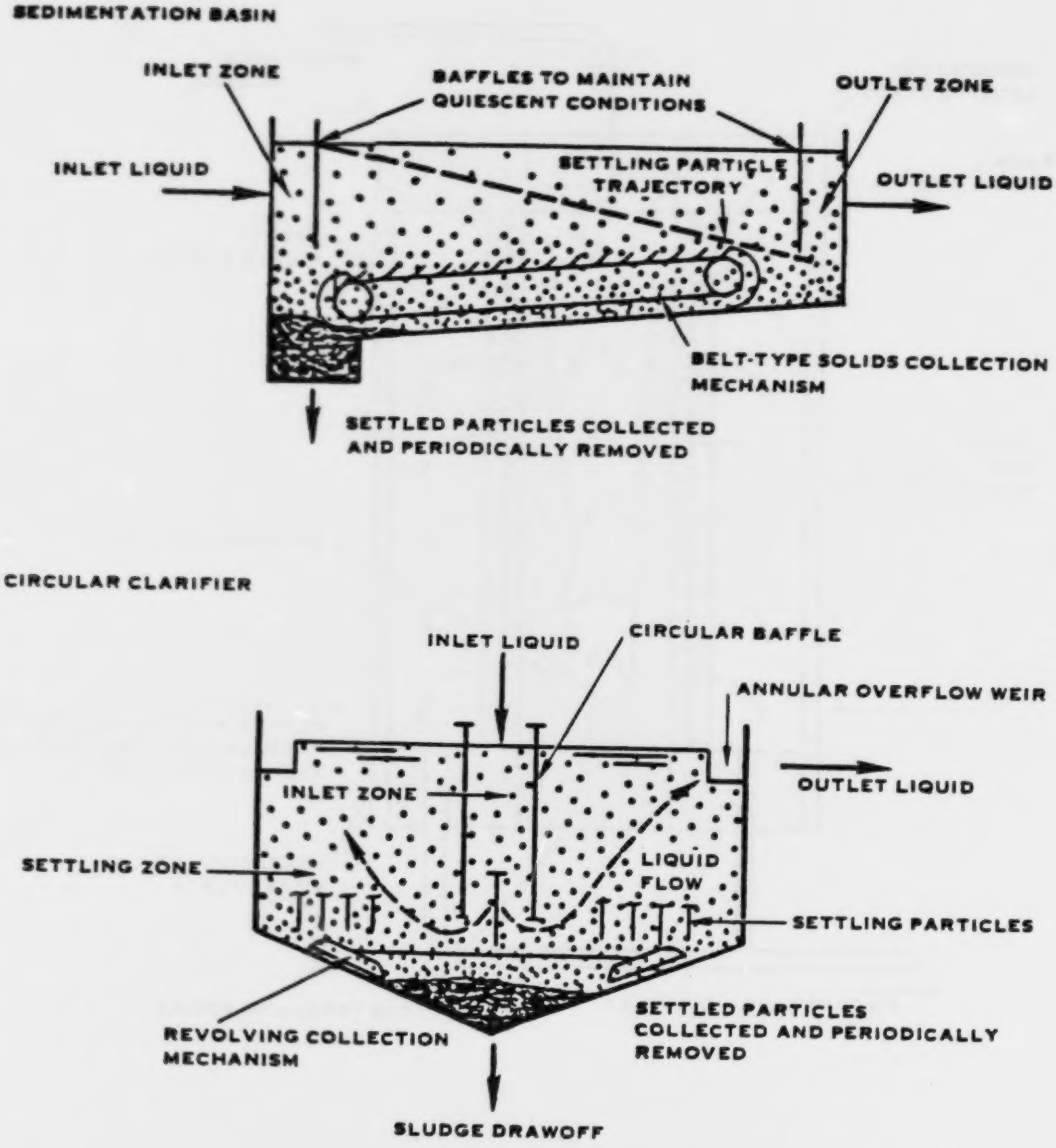

SEDIMENTATION BASIN
INLET ZONE
BAFFLES TO MAINTAIN QUIESCENT CONDITIONS
OUTLET ZONE
INLET LIQUID
SETTLING PARTICLE TRAJECTORY
OUTLET LIQUID
BELT-TYPE SOLIDS COLLECTION MECHANISM
SETTLED PARTICLES COLLECTED AND PERIODICALLY REMOVED
CIRCULAR CLARIFIER
INLET LIQUID
CIRCULAR BAFFLE
ANNULAR OVERFLOW WEIR
OUTLET LIQUID
INLET ZONE
SETTLING ZONE
LIQUID FLOW
SETTLING PARTICLES
SETTLED PARTICLES COLLECTED AND PERIODICALLY REMOVED
REVOLVING COLLECTION MECHANISM
SLUDGE DRAWOFF

FIGURE VII-16. REPRESENTATIVE TYPES OF SEDIMENTATION

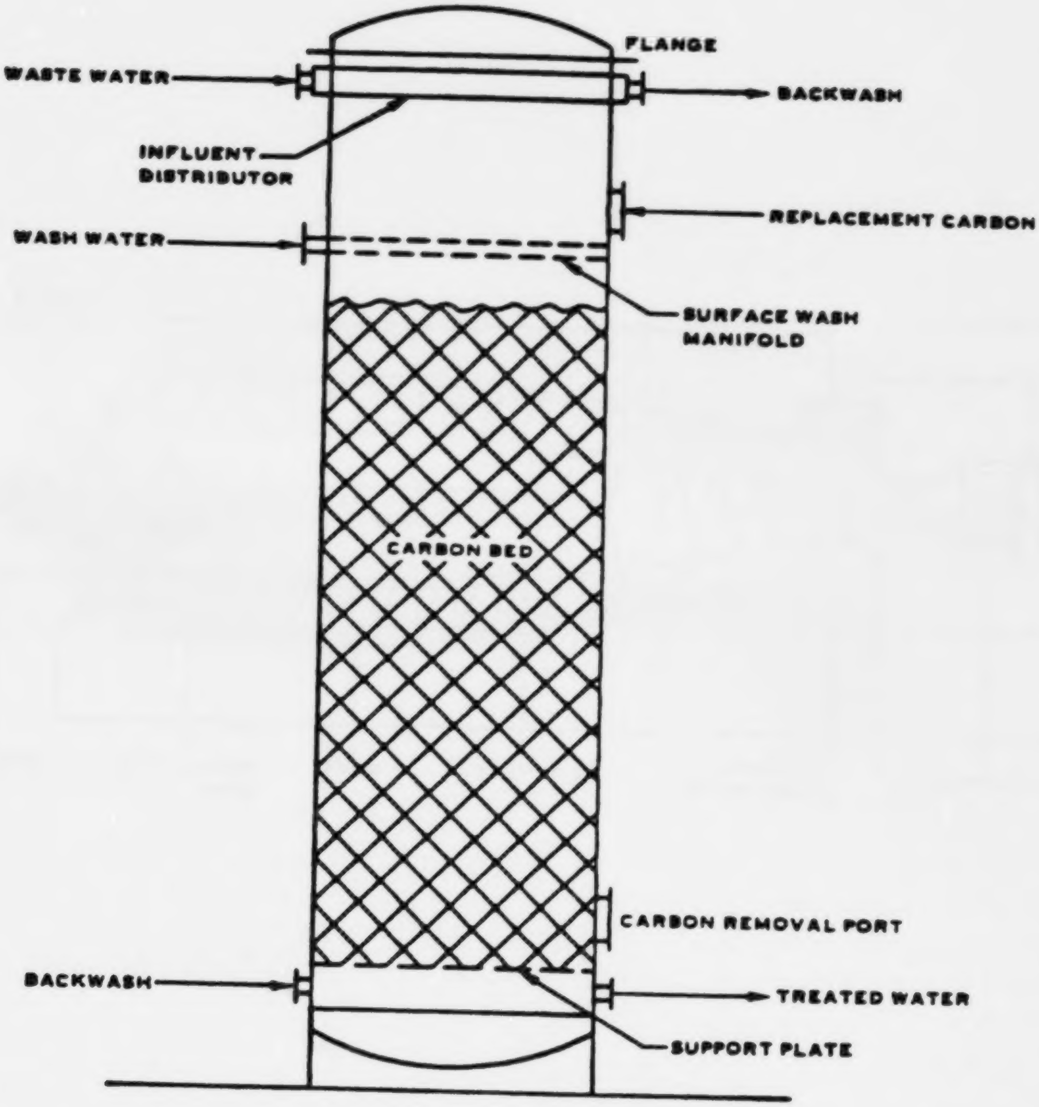


FIGURE VII-17. ACTIVATED CARBON ADSORPTION COLUMN

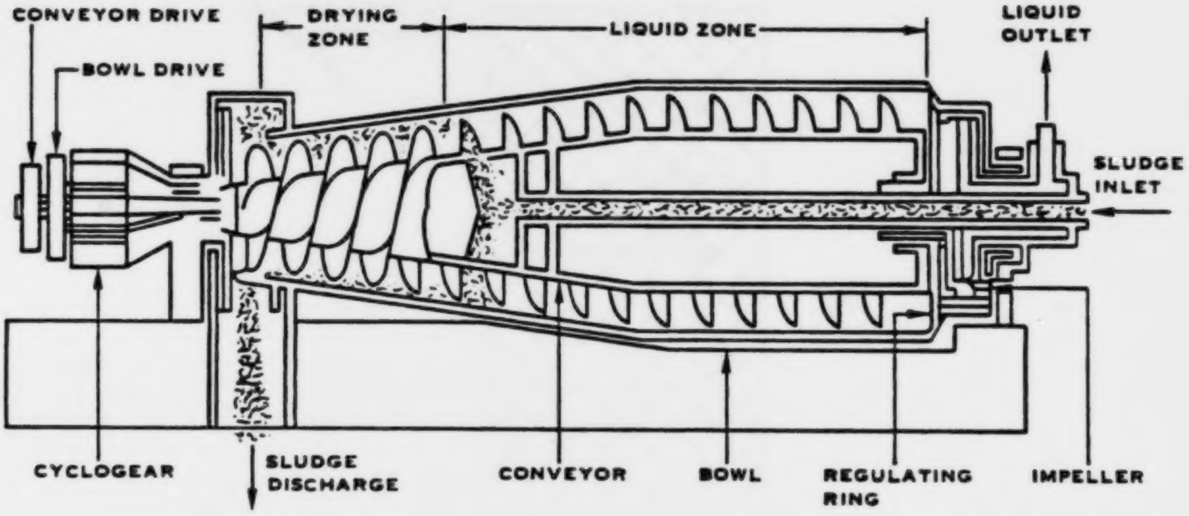


FIGURE VII-18. CENTRIFUGATION

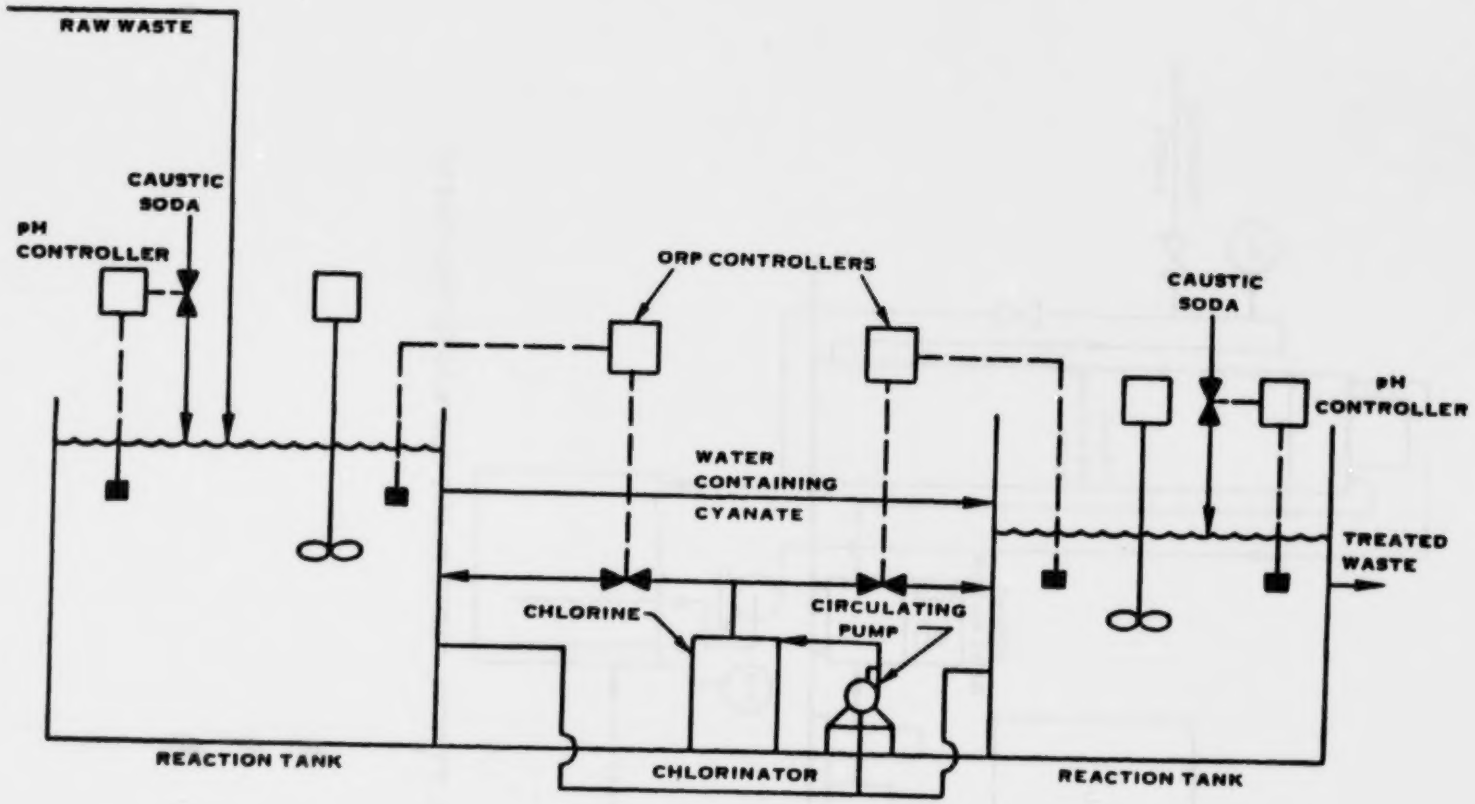


FIGURE VII-19. TREATMENT OF CYANIDE WASTE BY ALKALINE CHLORINATION

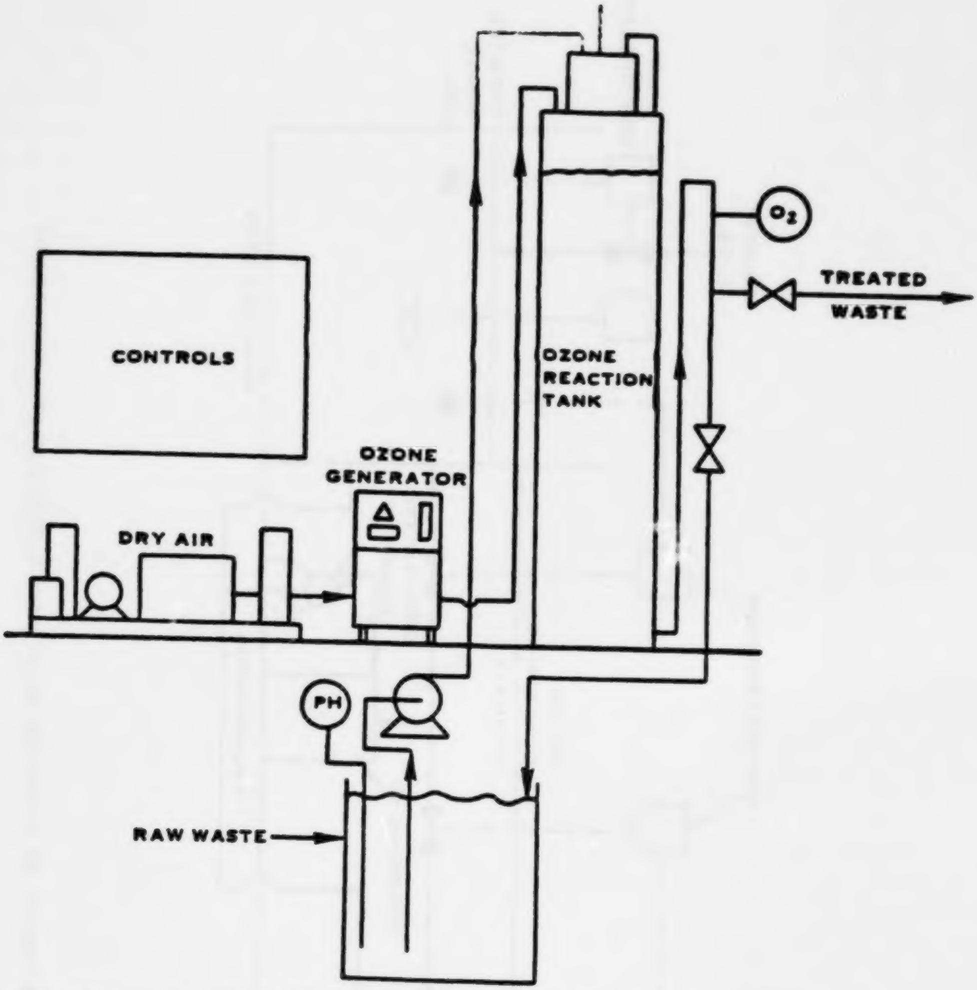


FIGURE VII-20. TYPICAL OZONE PLANT FOR WASTE TREATMENT

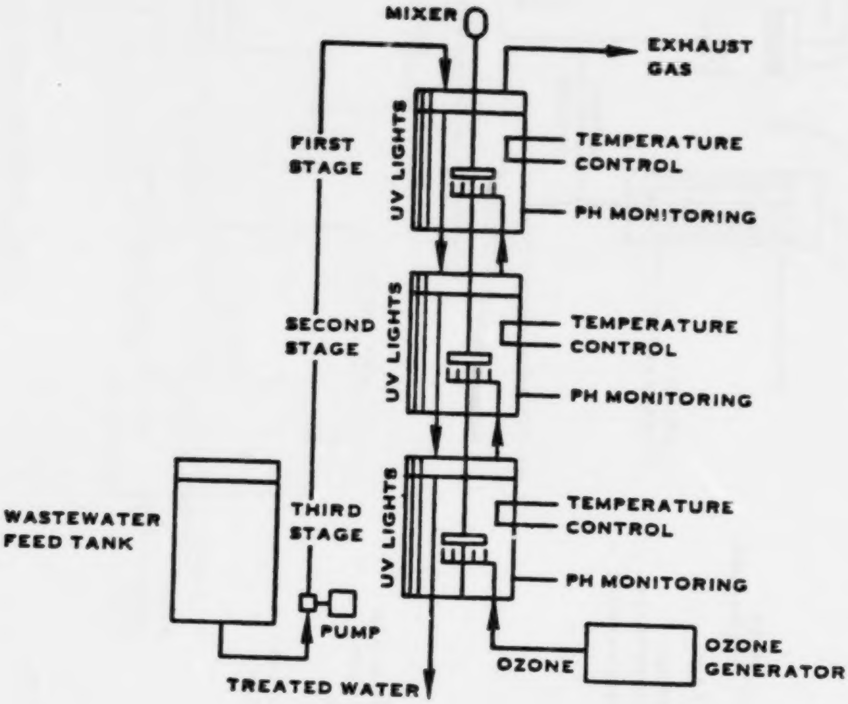
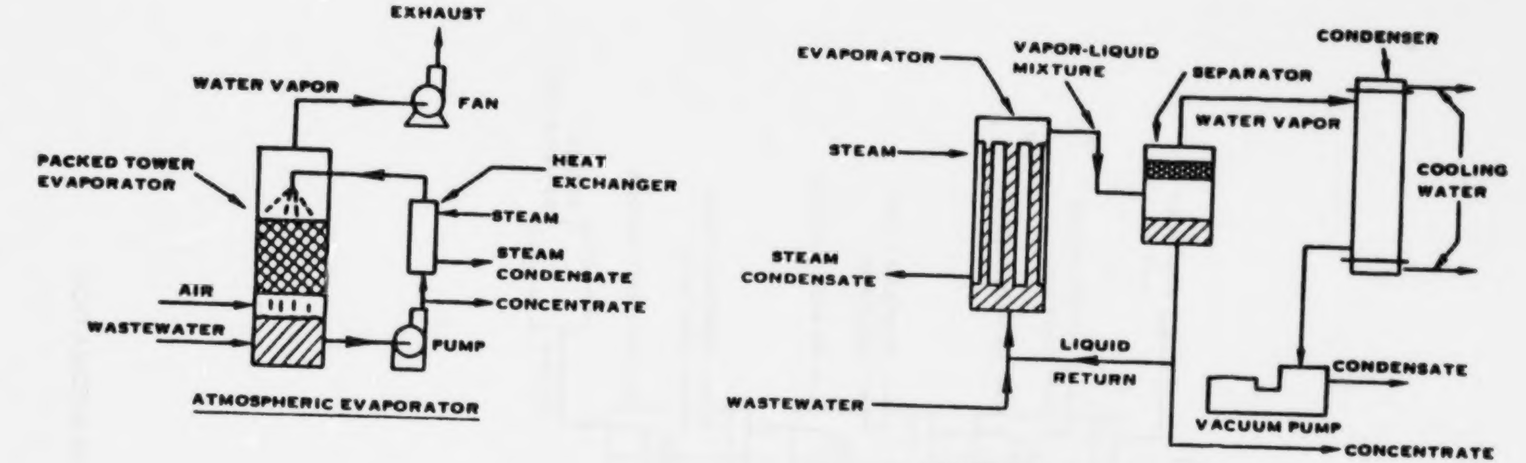
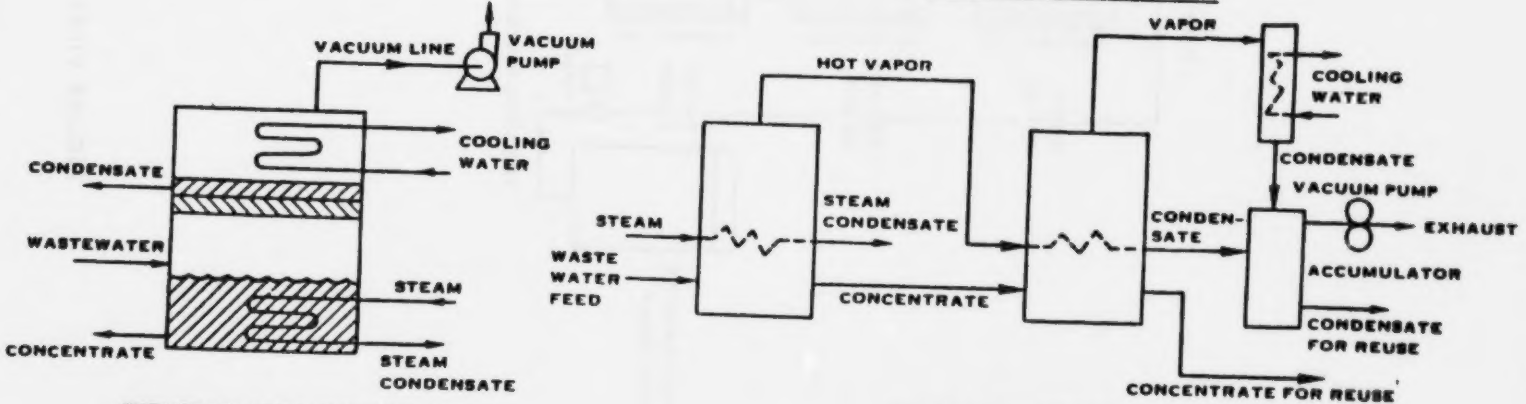


FIGURE VII-21. UV/OZONATION



ATMOSPHERIC EVAPORATOR

CLIMBING FILM EVAPORATOR



SUBMERGED TUBE EVAPORATOR

DOUBLE-EFFECT EVAPORATOR

FIGURE VII-22. TYPES OF EVAPORATION EQUIPMENT

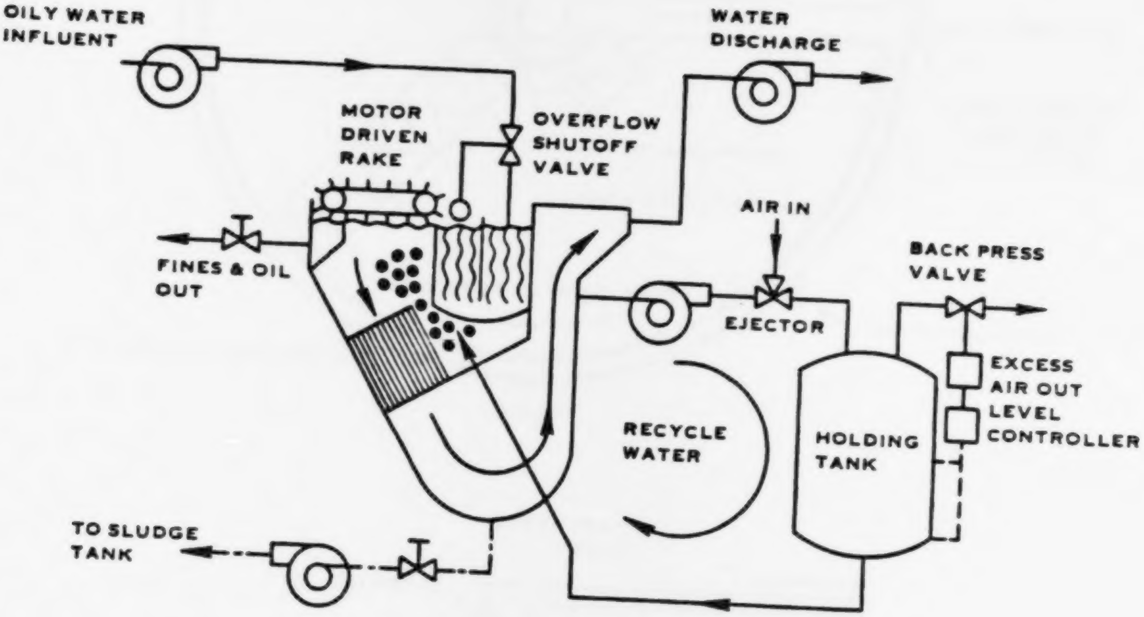
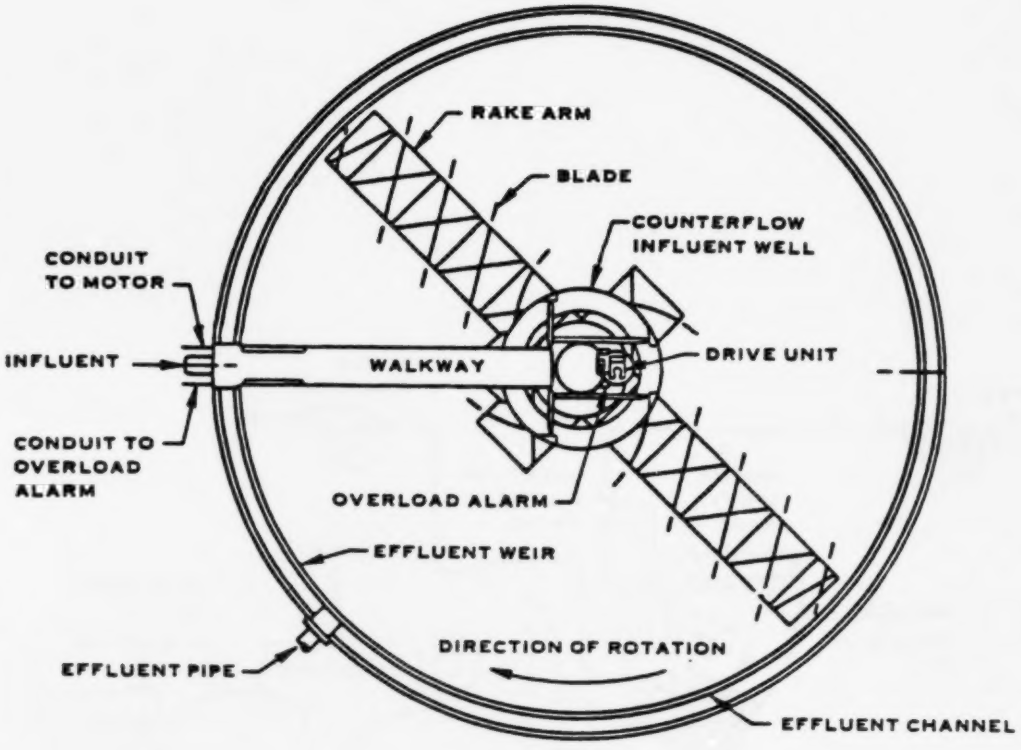


FIGURE VII-23. DISSOLVED AIR FLOTATION



PLAN

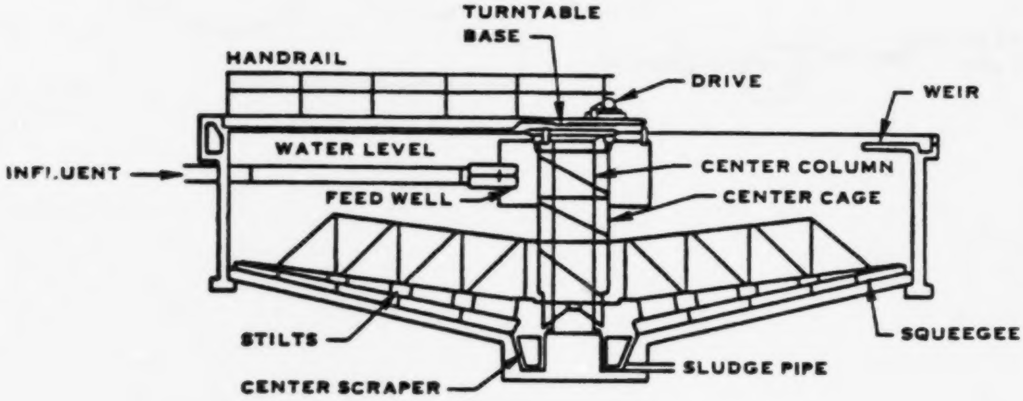


FIGURE VII-24. GRAVITY THICKENING

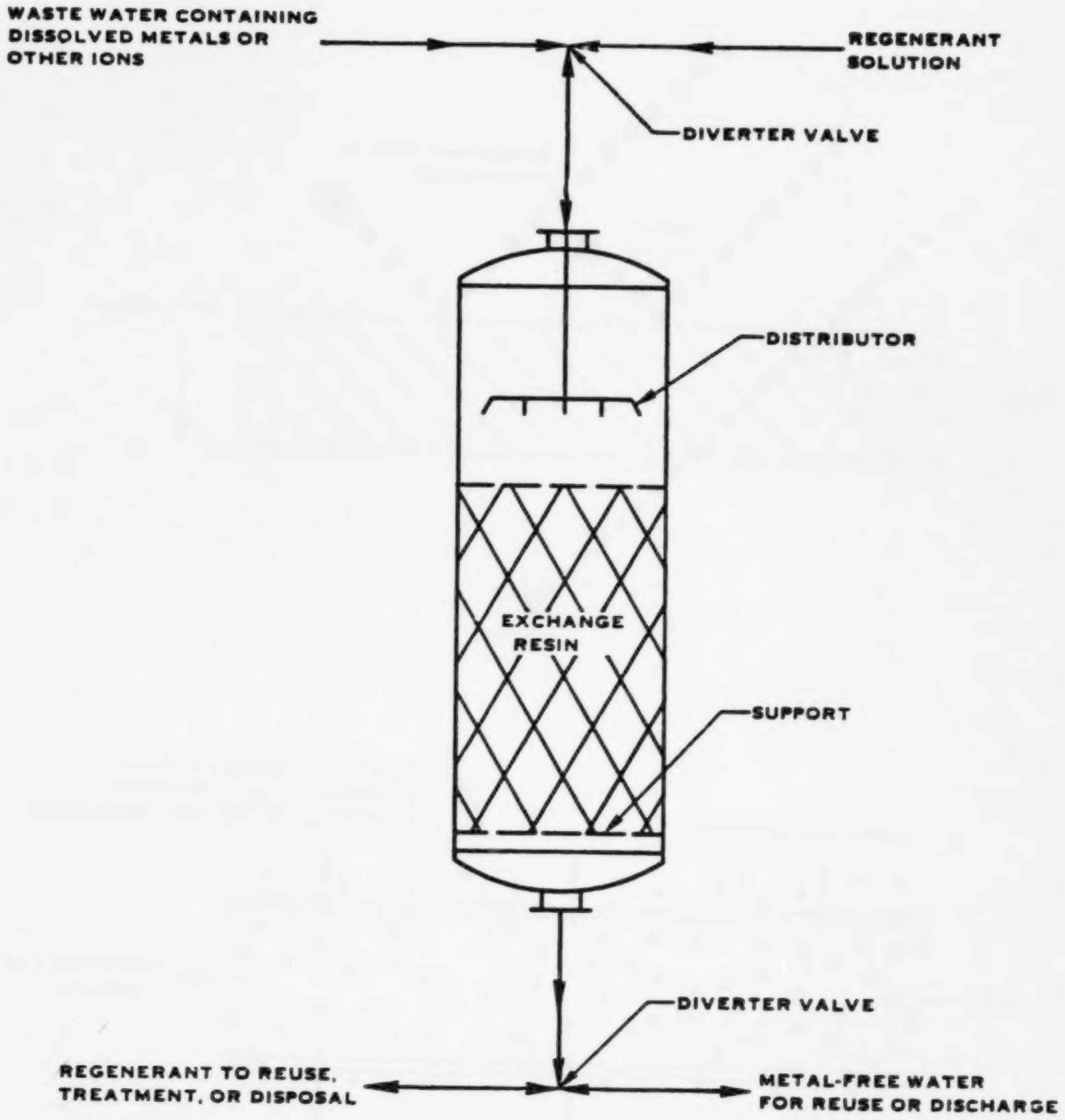

WASTE WATER CONTAINING DISSOLVED METALS OR OTHER IONS
REGENERANT SOLUTION
DIVERTER VALVE
DISTRIBUTOR
EXCHANGE RESIN
SUPPORT
DIVERTER VALVE
REGENERANT TO REUSE, TREATMENT, OR DISPOSAL
METAL-FREE WATER FOR REUSE OR DISCHARGE

FIGURE VII-25. ION EXCHANGE WITH REGENERATION

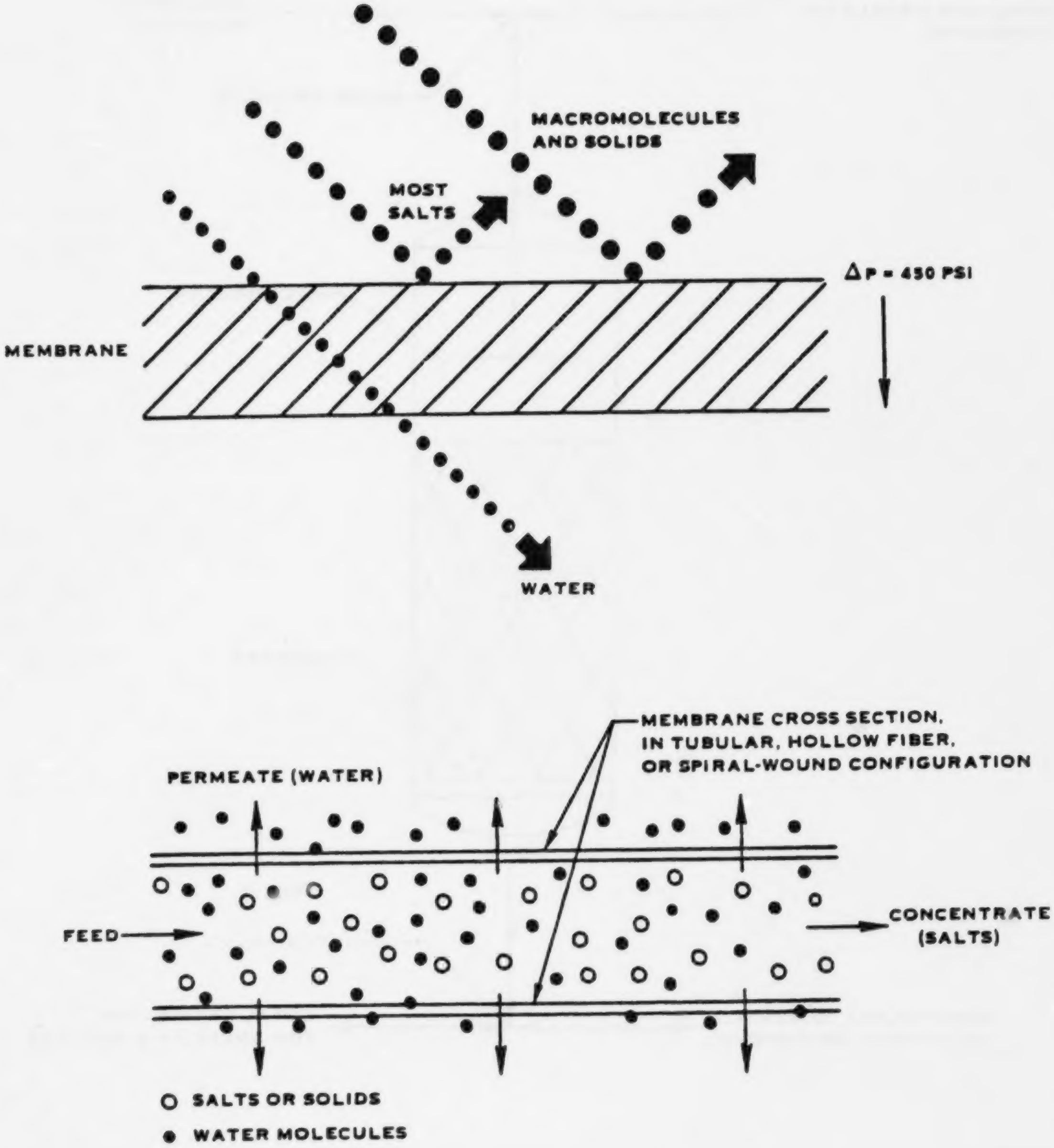
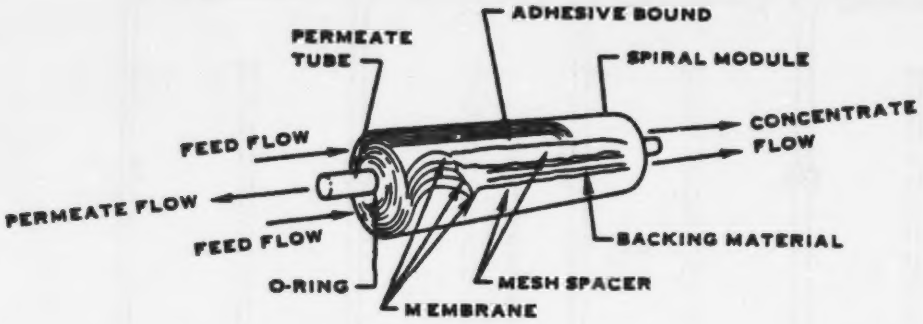
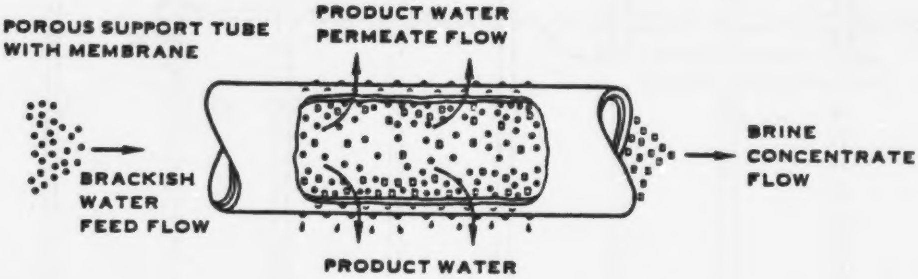


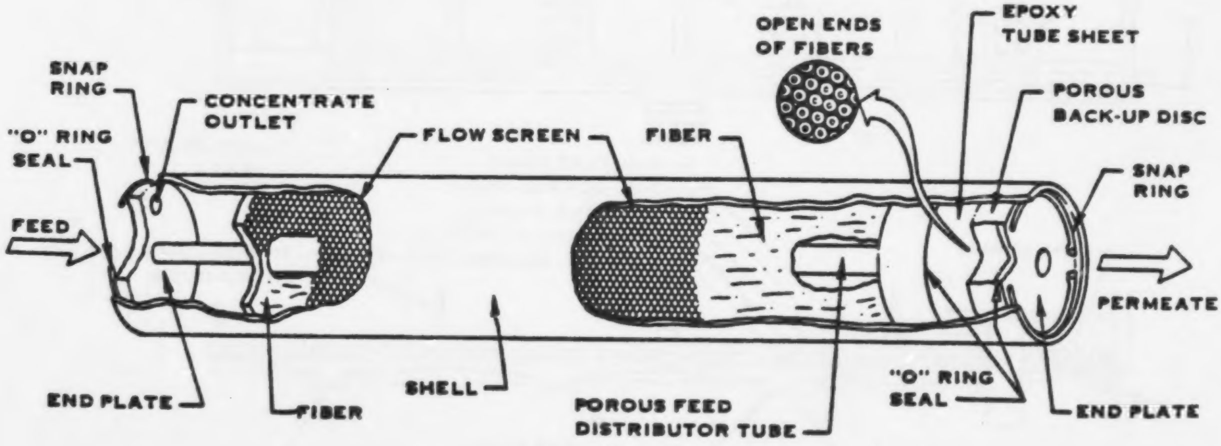
FIGURE VII-26. SIMPLIFIED REVERSE OSMOSIS SCHEMATIC



SPIRAL MEMBRANE MODULE


PRODUCT WATER PERMEATE FLOW
POROUS SUPPORT TUBE WITH MEMBRANE
BRACKISH WATER FEED FLOW
BRINE CONCENTRATE FLOW
PRODUCT WATER

TUBULAR REVERSE OSMOSIS MODULE



HOLLOW FIBER MODULE

FIGURE VII-27. REVERSE OSMOSIS MEMBRANE CONFIGURATIONS

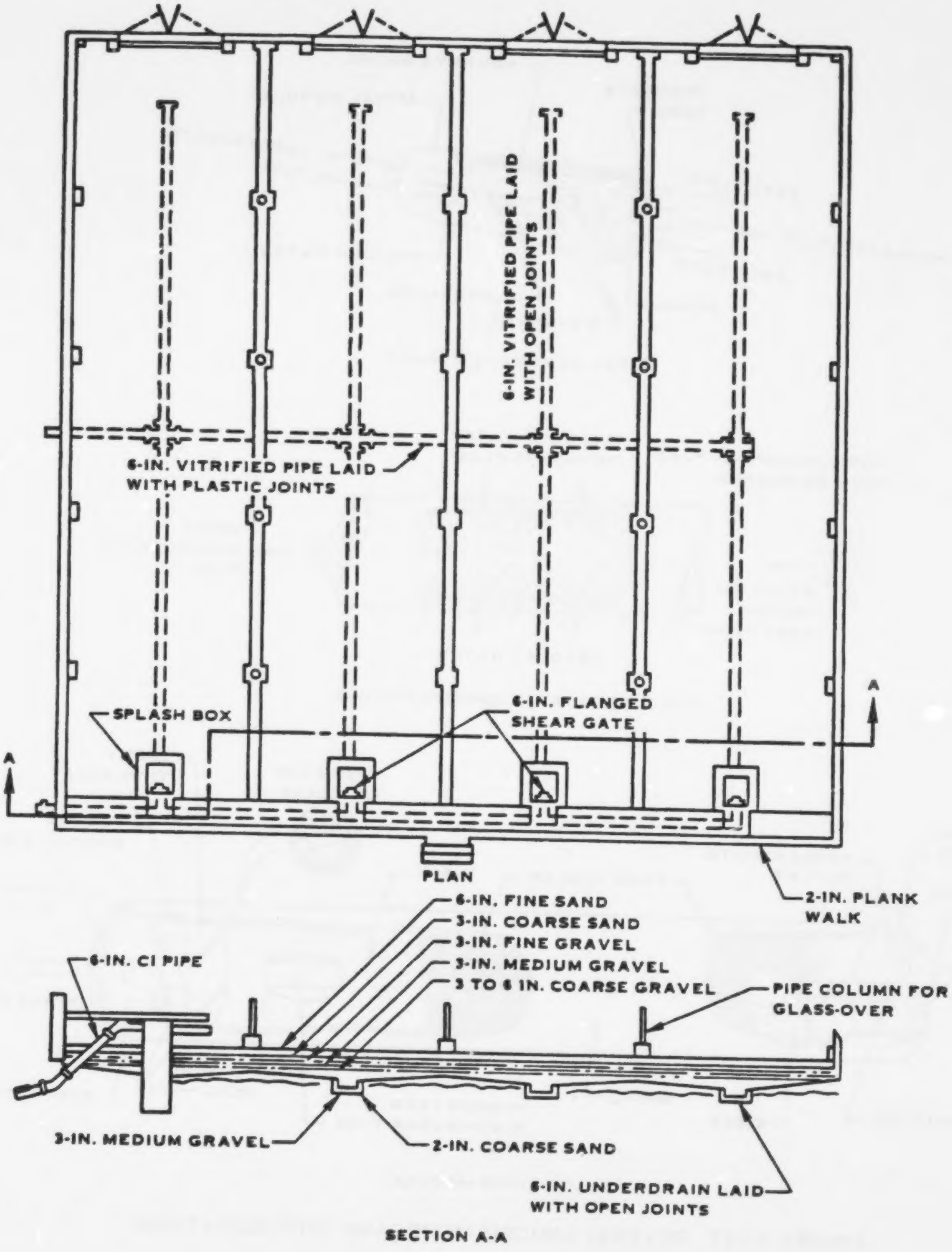


FIGURE VII-28. SLUDGE DRYING BED

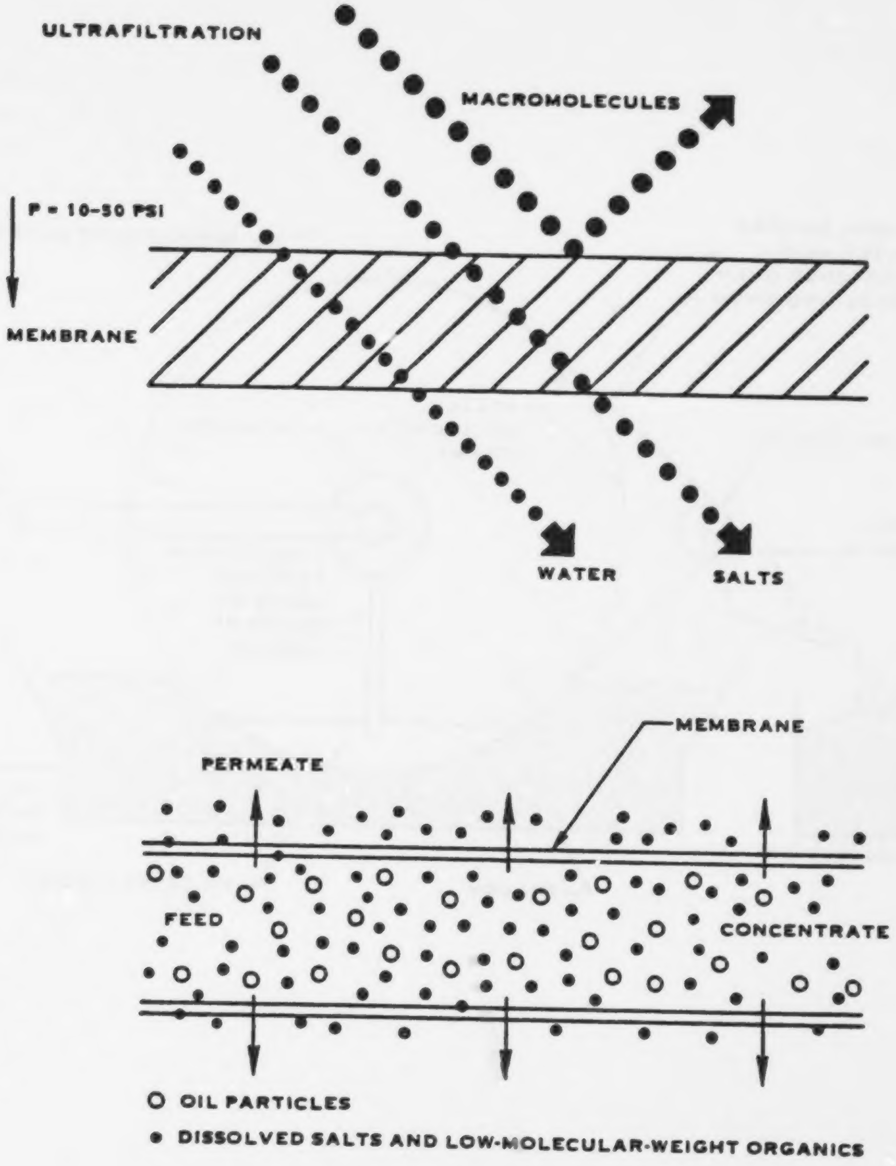


FIGURE VII-29. SIMPLIFIED ULTRAFILTRATION FLOW SCHEMATIC

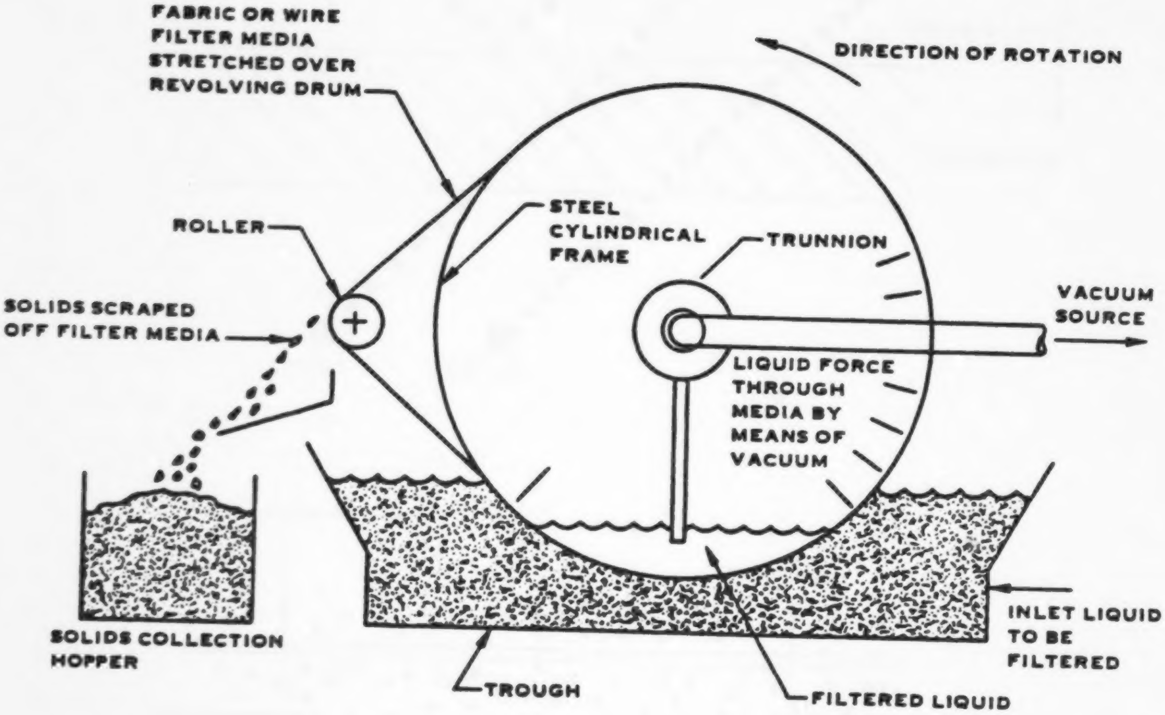

FABRIC OR WIRE FILTER MEDIA STRETCHED OVER REVOLVING DRUM
DIRECTION OF ROTATION
ROLLER
STEEL CYLINDRICAL FRAME
TRUNNION
VACUUM SOURCE
SOLIDS SCRAPED OFF FILTER MEDIA
LIQUID FORCE THROUGH MEDIA BY MEANS OF VACUUM
SOLIDS COLLECTION HOPPER
INLET LIQUID TO BE FILTERED
TROUGH
FILTERED LIQUID

FIGURE VII-30. VACUUM FILTRATION

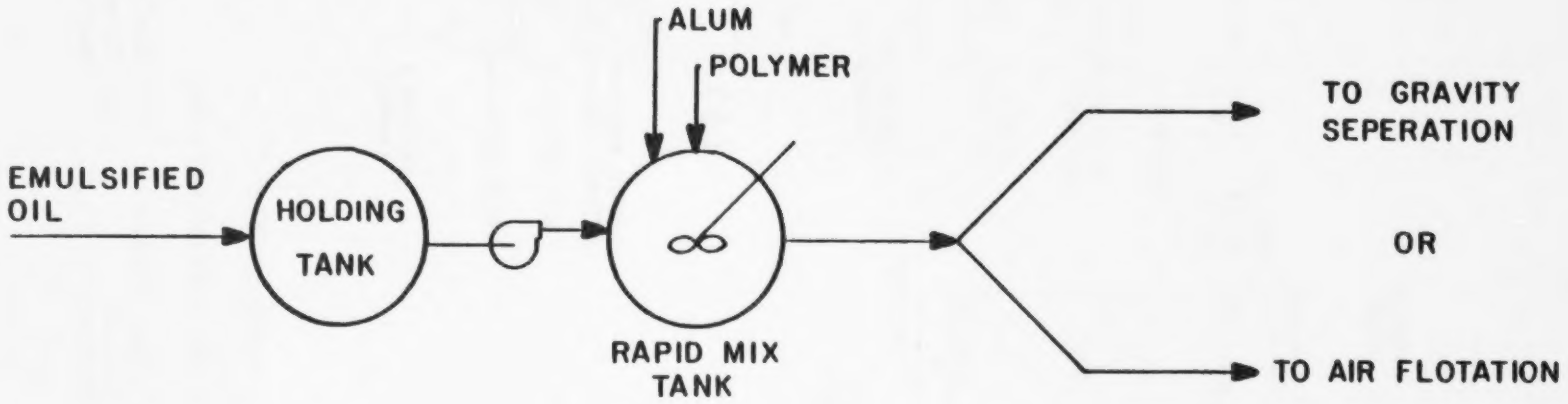


Figure VII-31

FLOW DIAGRAM FOR EMULSION BREAKING WITH CHEMICALS

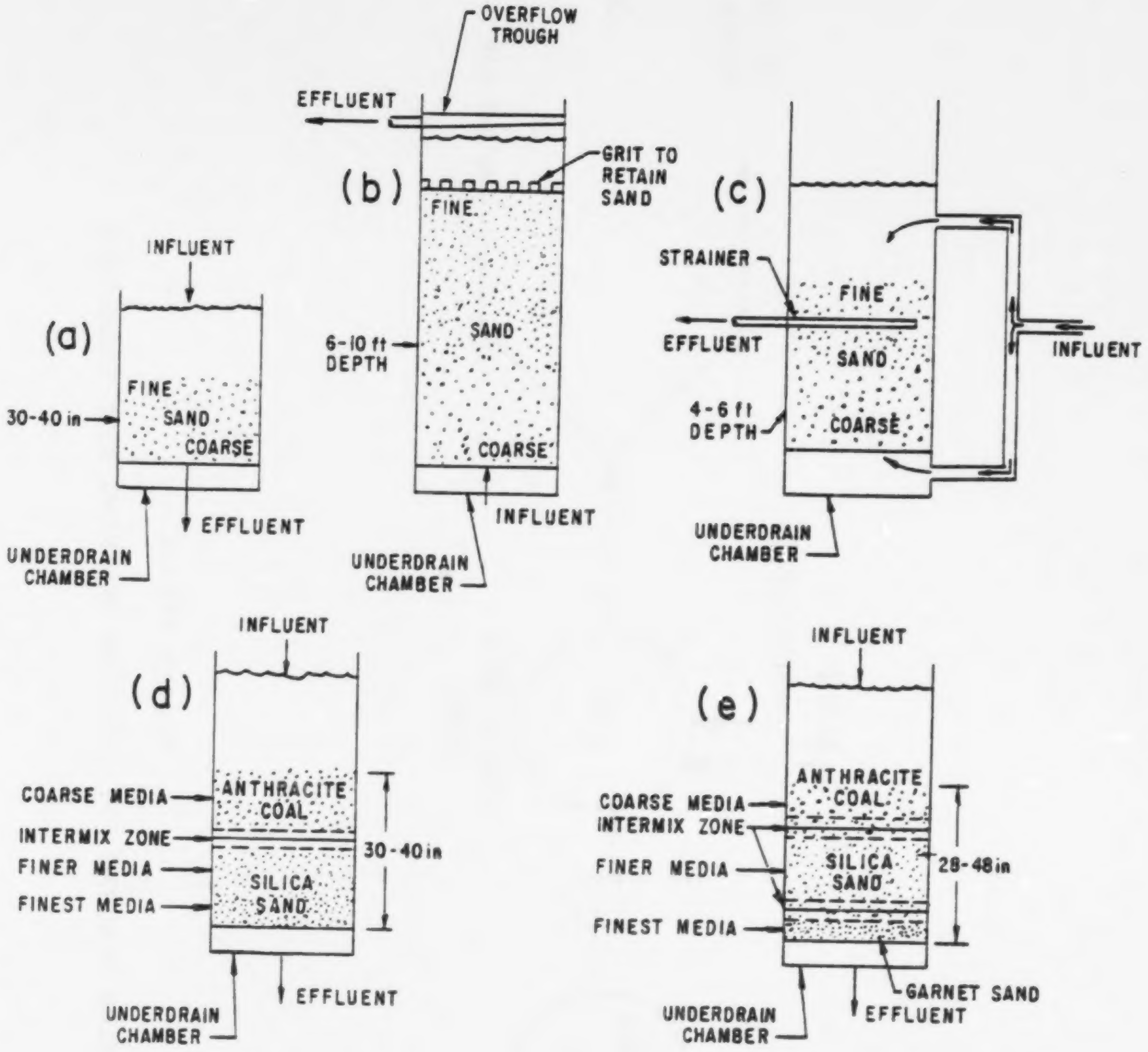


Figure VII-32

FILTER CONFIGURATIONS

(a) Single-Media Conventional Filter.
(b) Single-Media Upflow Filter.
(c) Single-Media Biflow Filter.
(d) Dual-Media Filter.
(e) Mixed-Media (Triple-Media) Filter.

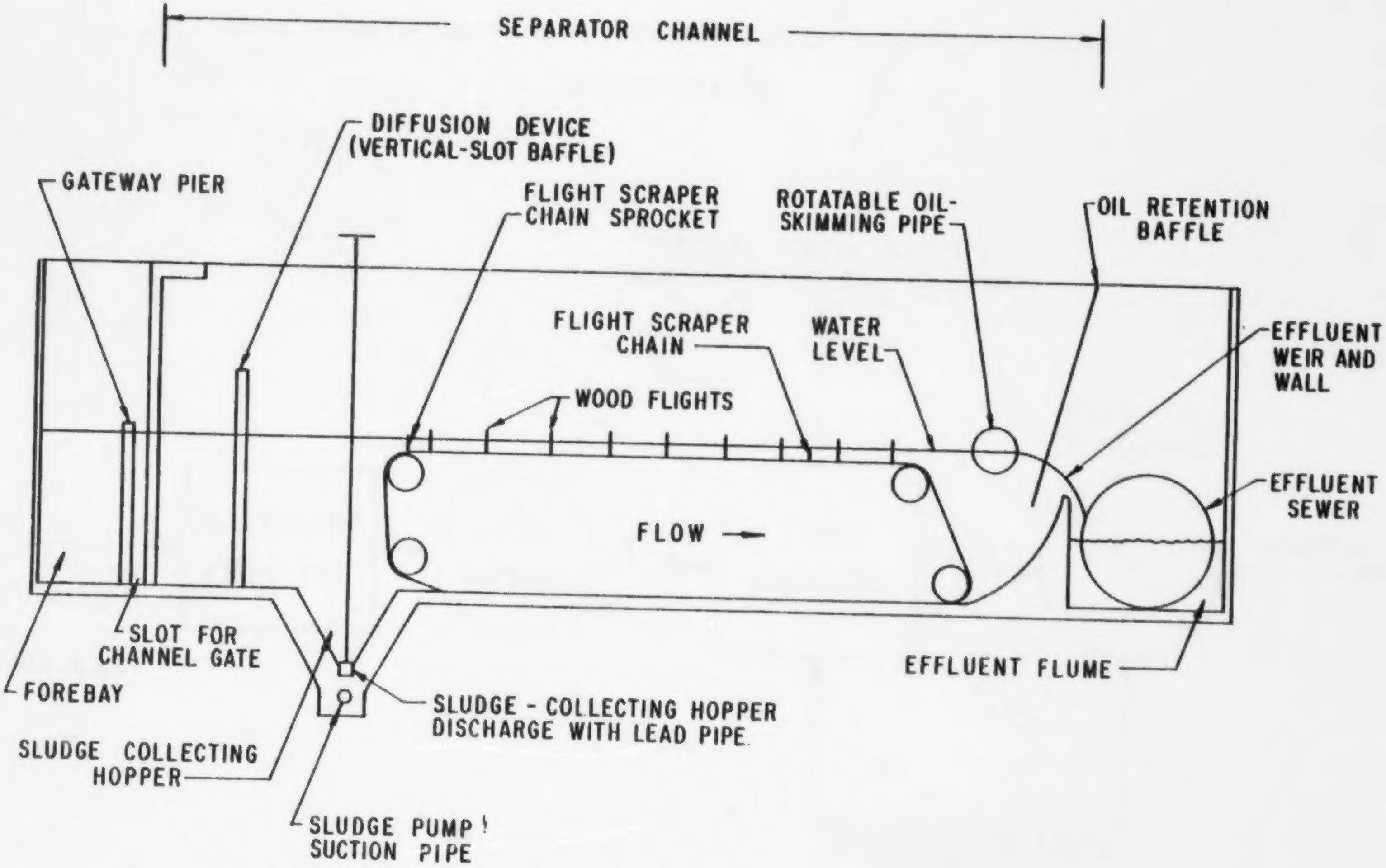


Figure VII-33

GRAVITY OIL/WATER SEPARATOR

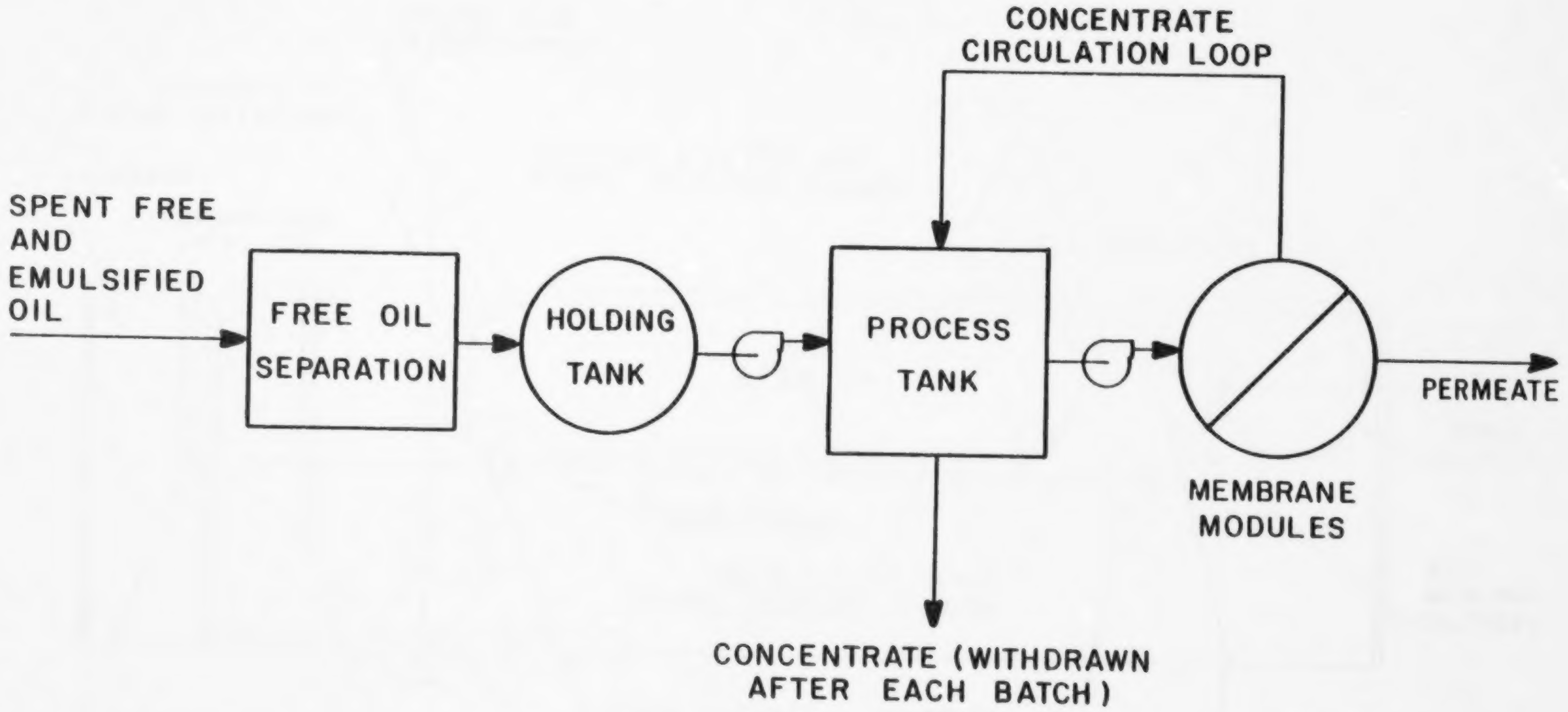

SPENT FREE AND EMULSIFIED OIL
FREE OIL SEPARATION
HOLDING TANK
PROCESS TANK
CONCENTRATE CIRCULATION LOOP
MEMBRANE MODULES
PERMEATE
CONCENTRATE (WITHDRAWN AFTER EACH BATCH)

Figure VII-34

FLOW DIAGRAM FOR A BATCH TREATMENT ULTRAFILTRATION SYSTEM

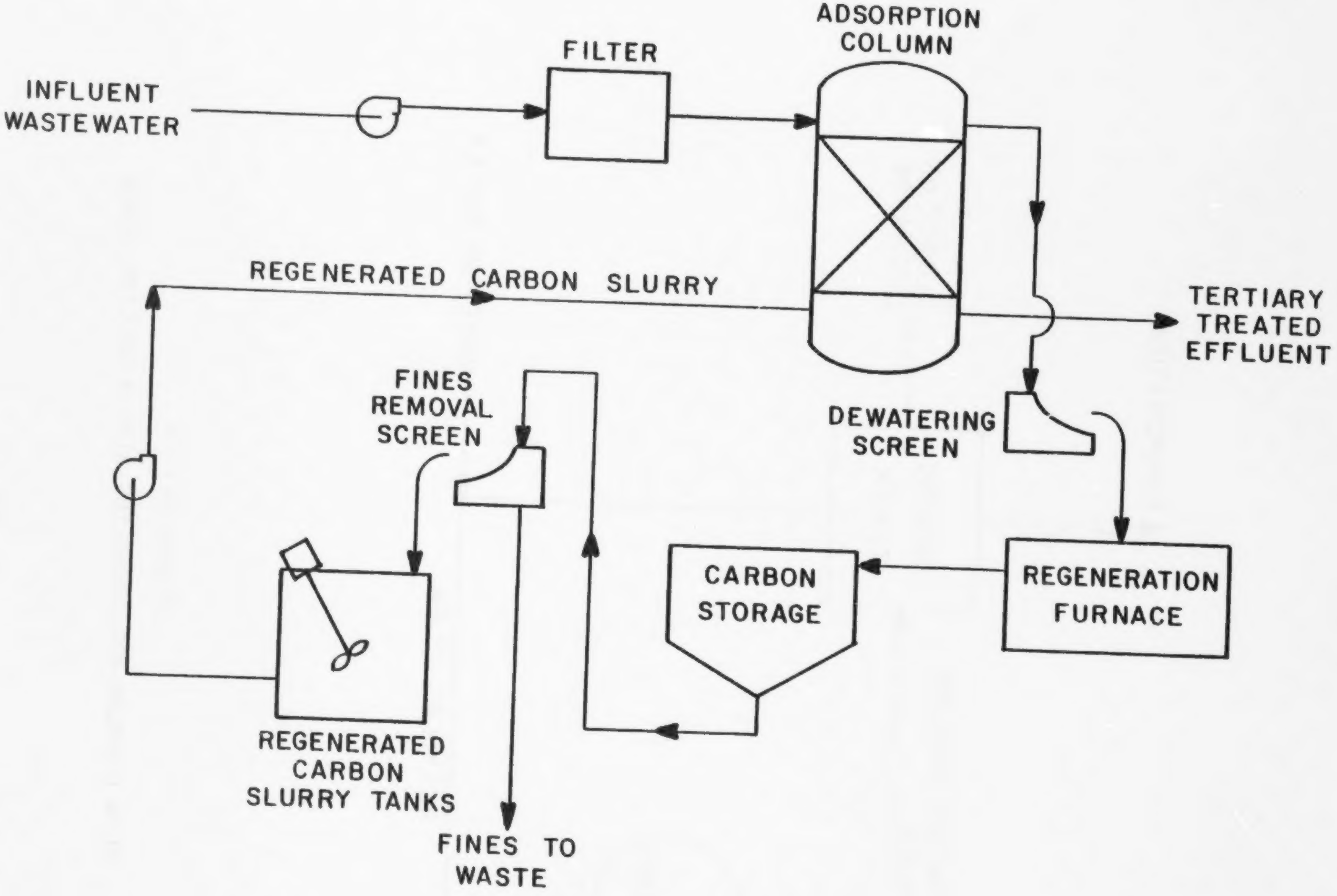


Figure VII-35

FLOW DIAGRAM OF ACTIVATED CARBON ADSORPTION WITH REGENERATION

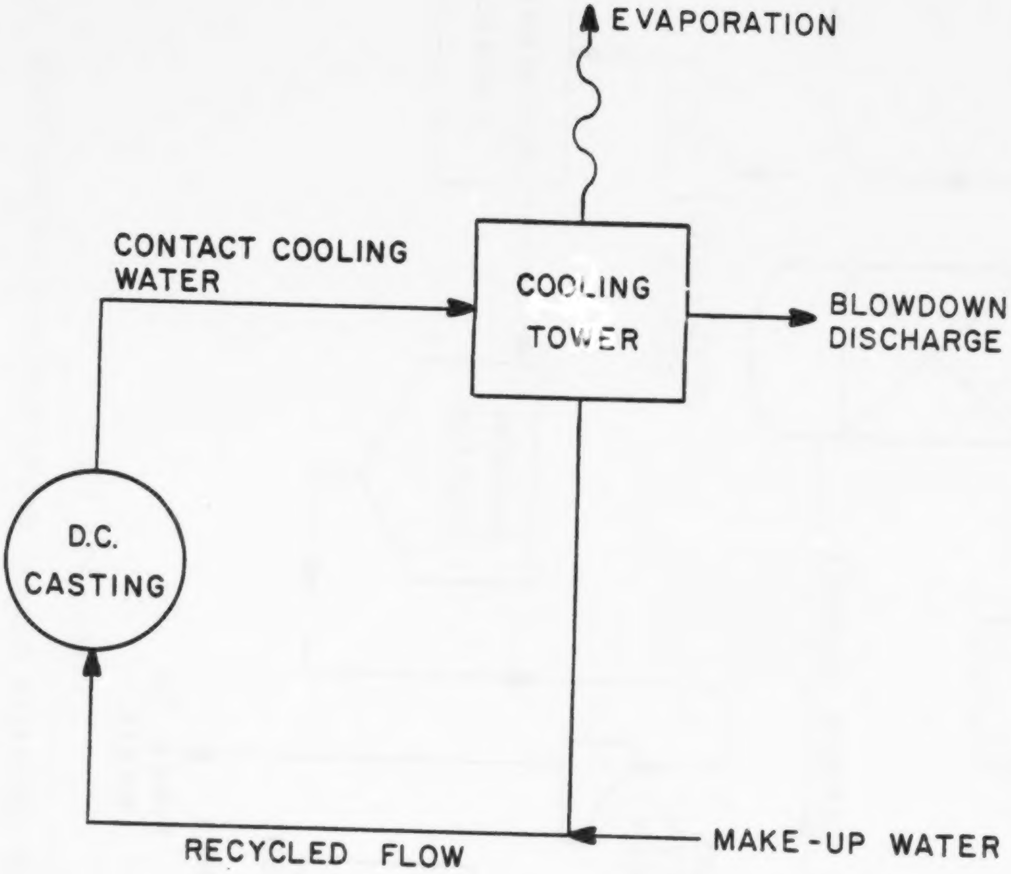


Figure VII-36

FLOW DIAGRAM FOR RECYCLING WITH A COOLING TOWER

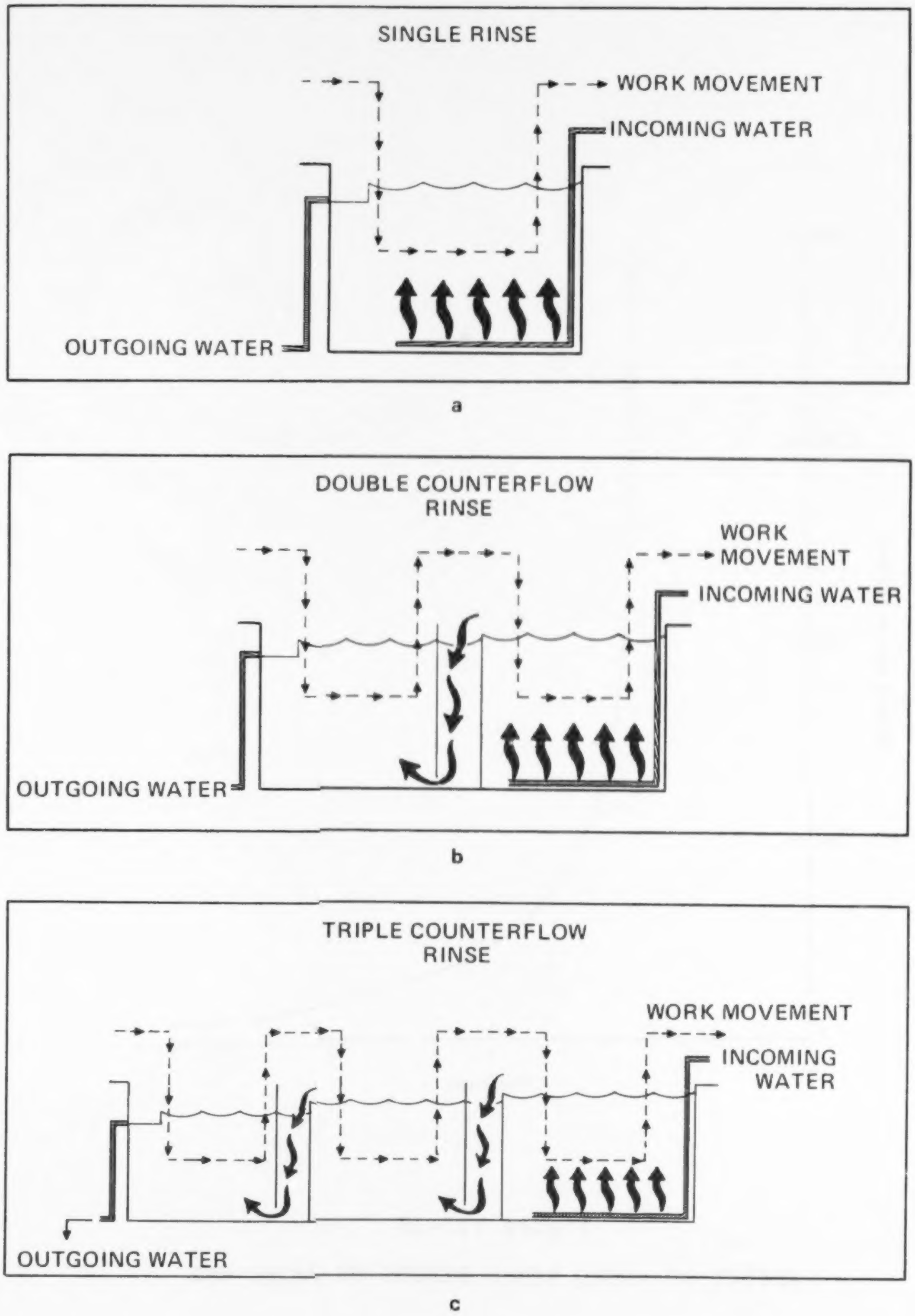


Figure VII-37

COUNTER CURRENT RINSING (TANKS)

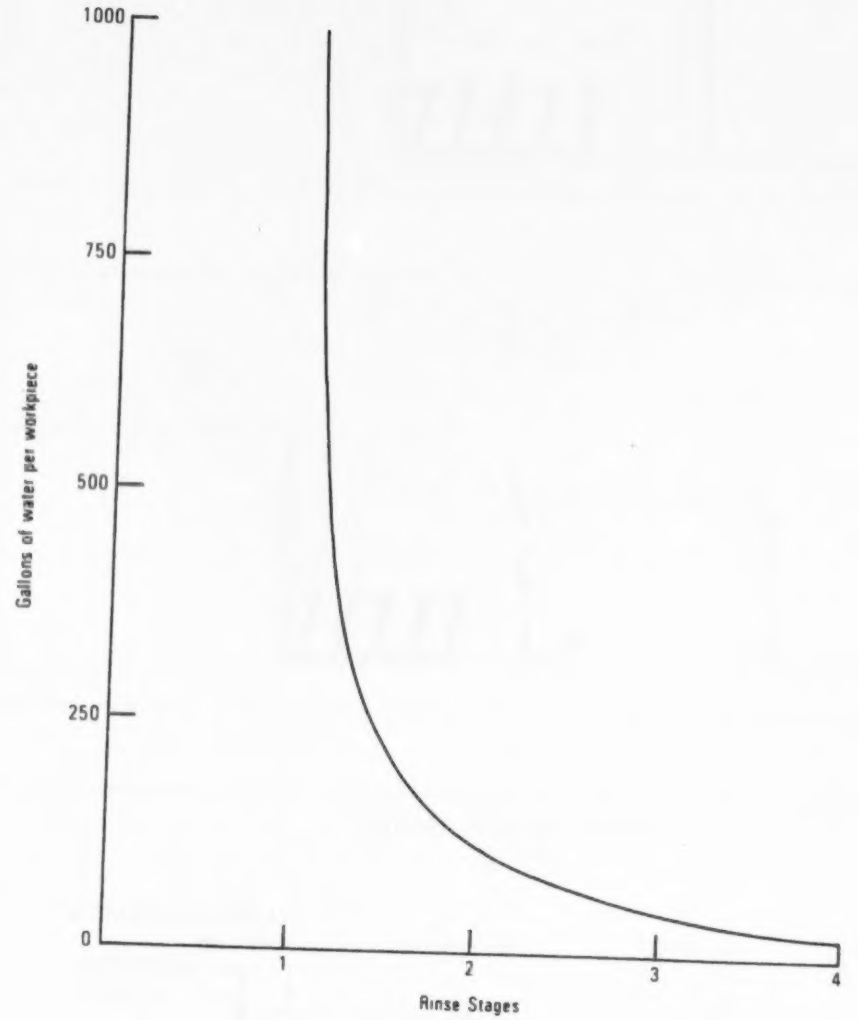


Figure VII-38

EFFECT OF ADDED RINSE STAGES ON WATER USE

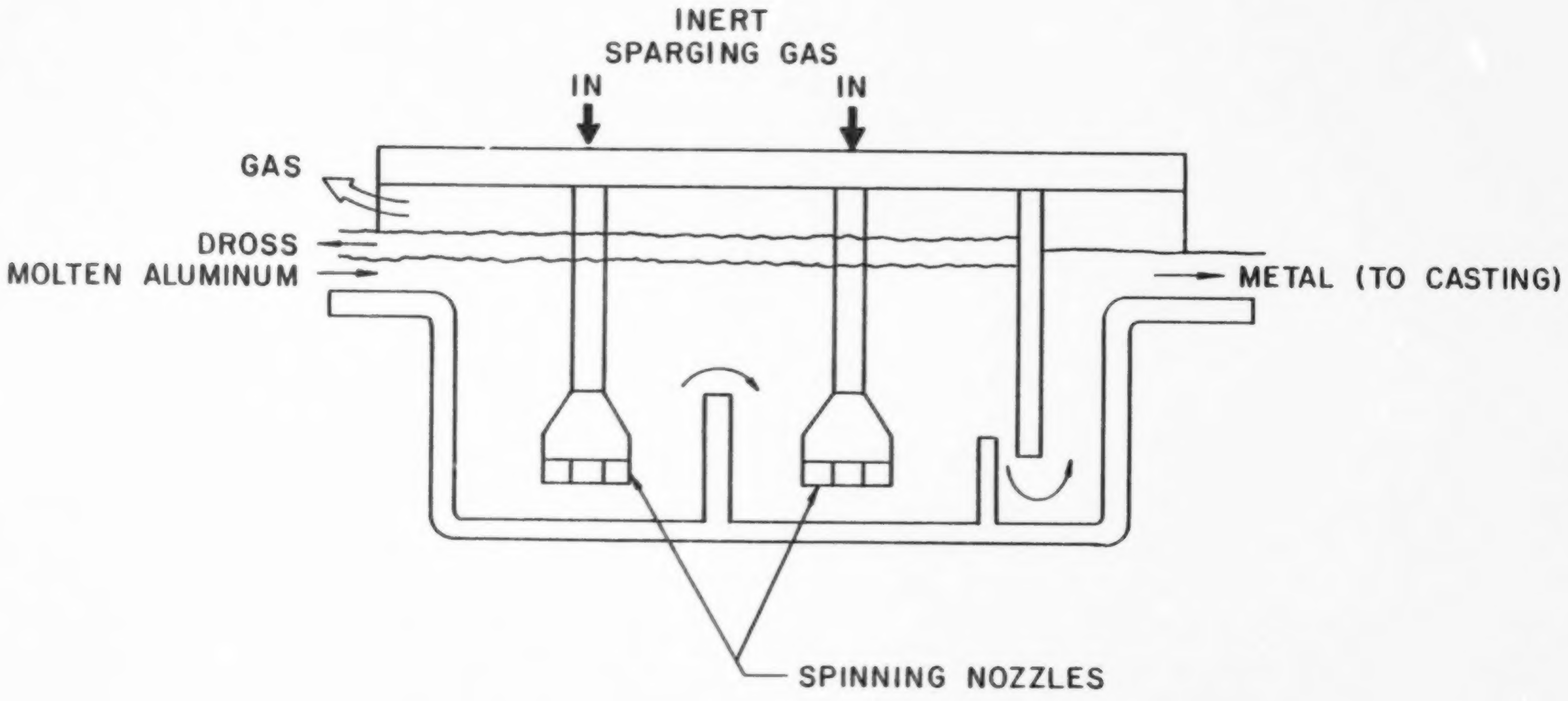


Figure VII-39

SCHEMATIC DIAGRAM OF SPINNING NOZZLE ALUMINUM REFINING PROCESS

SECTION VIII

COST OF WASTEWATER TREATMENT AND CONTROL

This section presents estimates of the costs of implementing the major wastewater treatment and control technologies described in Section VII. These cost estimates, together with the estimated pollutant reduction performance for each treatment and control option presented in Sections IX, X, XI, and XII, provide a basis for evaluating the options presented and identification of the best practicable technology currently available (BPT), best available technology economically achievable (BAT), best demonstrated technology (BDT), and the appropriate technology for pretreatment. The cost estimates also provide the basis for determining the probable economic impact on the aluminum forming category of regulation at different pollutant discharge levels. In addition, this section addresses nonwater quality environmental impacts of wastewater treatment and control alternatives, including air pollution, solid wastes, and energy requirements.

GENERAL APPROACH

Capital and annual costs associated with compliance with the aluminum forming regulation have been calculated on a plant-by-plant basis for 124 plants and extrapolated for the remainder (seven plants) in the aluminum forming category that discharge wastewater. These costs have been used as the basis for economic impact analysis of the category. Prior to proposal, costs were generated for 104 aluminum forming plants using the pre-proposal cost estimation methodology described below. After proposal, 26 additional plants were costed and added to the total; six plants were removed because of closure or because the plants no longer discharge wastewater; and 12 plants were recosted because of a methodological error that substantially overstated the cost to small plants. A total of 124 plants were costed for the final rulemaking. Costs estimated before proposal were made by the pre-proposal contractor (Contractor A) and the post-proposal costs estimated by the post-proposal contractor (Contractor B). Cost methodologies of the two contractors were compared by costing the identical plants and found to compare favorably.

Prior to estimating any new costs after proposal, a comparison of costs generated by the pre-proposal and post-proposal methodologies was performed. A study previously done in 1982, in which wastewater treatment system costs were estimated for 10 porcelain enameling plants was used to compare the pre-proposal and post-proposal cost methodologies. The results of this study showed that the costs generated by the two methodologies agreed well. The sum of the total capital costs estimated for the 10 plants by the post-proposal methodology was 5.5 percent higher than those

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obtained from the pre-proposal methodology. The average of the absolute percent deviations between the costs for each plant was 10.1 percent. The corresponding figures for the annual costs were -19.1 percent and -17.1 percent, respectively (the annual costs based on the pre-proposal methodology are higher). These results indicate that costs generated by the two cost methodologies are comparable, considering the accuracy of cost estimation. The principal cost factor differences between the pre-proposal and post-proposal costs are tabulated in Table VIII-1.

Also, in 1980 a 10-plant cost study (using the same porcelain enameling plants) was performed simultaneously by three separate contractors and compared with actual industry costs for five of the plants. The cost methodologies of all three contractors were within ±20 percent of the mean for each plant and the mean cost was within ±20 percent of the estimated industry costs on the five plants. The pre-proposal contractor was one of the three contractors that participated in the study. As discussed above, the post-proposal contractor also estimated the same 10 plants and had capital costs about 5 percent above the pre-proposal contractor costs. Additionally, one of the three contractors compared the estimated compliance costs for 80 steel plants with actual costs incurred by the companies and found the model costs to overestimate actual costs by about 10 percent. The costs actually incurred included site-specific costs such as line segregation, area rehabilitation, and retrofit of equipment. All of these costs were adequately compensated by the cost estimating factors included in the methodology.

As a result of this comparison, the Agency concluded that it was reasonable to perform post-proposal costing efforts using the new cost methodology and to combine these new costs with those generated prior to proposal.

COST ESTIMATION METHODOLOGY: PRE-PROPOSAL

Sources of Cost Data

Capital and annual cost data for the selected treatment processes were collected from four sources: (1) literature, (2) data collection portfolios, (3) equipment manufacturers, and (4) in-house design projects. The majority of the cost information was obtained from literature sources. Many of the literature sources cited obtained their costs from surveys of actual design projects. For example, Black & Veatch prepared a cost manual that used design and construction cost data from 76 separate projects as a basis for establishing average construction costs. Data collection portfolios completed by companies in the aluminum forming category contained a limited amount of chemical and unit process cost information. Most of the dcp's did not include treatment plant capital or information was annual cost information, and reported for the entire treatment plant. Therefore, little data from the data collection portfolios was applicable for the determination of individual unit process costs. Additional data was obtained from equipment manufacturers and design projects performed by Sverdrup & Parcel and Associates.

Determination of Costs

To determine capital and annual costs for the selected treatment technologies, cost data from all sources were plotted on a graph of capital or annual costs versus a design parameter (usually flow). These data were usually spread over a range of flows. Unit process cost data gathered from all sources include a variety of auxiliary equipment, basic construction materials, and geographical locations. A single line was fitted to the data points thus arriving at a final cost curve closely representing an average of all the cost references for a unit process. Since the cost estimates presented in this section must be applicable to treatment needs in varying circumstances and geographic locations, this approach was felt to be the best for determining national treatment costs. For consistency in determining costs, accuracy in reading the final cost curves, and in order to present all cost relationships concisely, equations were developed to represent the final cost curves. The cost curves are presented in Figures VIII-1 through VIII-30, capital and annual cost equations are listed in Table VIII-2.

All cost information was standardized by backdating or updating the costs to first quarter 1978. Two indices were used: (1) EPA - Standard Treatment Plant index and (2) EPA - Large City Advanced Treatment (LCAT) index. The national average, rather than an index value for a particular city, was used for the EPA-LCAT index. The national average was used because the regional differential of the supporting cost data was dampened by averaging the cost data.

Capital. All capital cost equations include:

(1) Major and auxiliary equipment
(2) Piping and pumping
(3) Shipping
(4) Sitework
(5) Installation
(6) Contractors' fees
(7) Electrical and instrumentation
(8) Enclosure
(9) Yard piping
(10) Engineering
(11) Contingency

Items (1) through (7) are included to the extent that they are provided for in each source in the literature. In cases where a certain item(s) is missing, an estimate is made in order to average the cost values. Enclosure costs are estimated separately and are included only for those technologies' performances deemed subject to weather conditions. Contingencies and engineering are assumed to be 15 and 10 percent, respectively, of the installed equipment cost. Yard piping is estimated at 10 percent of the installed equipment cost.

The cost of land has not been considered in the cost estimates. Based on engineering visits at 22 aluminum forming plants, it is believed that most wastewater treatment and supporting facilities can be constructed in existing buildings or on land currently owned by the plants. Also, the plant wastewater flows in the aluminum forming category are low (majority of plants less than 50,000 gpd); thus, land requirements for treatment facilities are small for most plants.

For new plants, the amount of land necessary to house the wastewater treatment system is assumed to be insignificant relative to other capital costs. This is particularly true since the plant design would optimize the space available.

The non-water quality aspects associated with capital costs include sludge handling for precipitation and skimming systems generating large quantities of sludge. Capital investment is required only for systems generating greater than 140,000 gallons per year in order to dewater the sludge prior to hauling. This is based on economic assessment of the break point for sludge hauling and landfilling. The 140,000 gallon per year volume is the volume at which contract hauling at a cost of thirty cents per gallon (discussed later in this section) would equal the investment costs for a vacuum filtration system. Investment includes costs for vacuum filtration and holding tanks. See the cost calculation example for further detail.

Annual. All annual cost equations include:

- Operation and maintenance labor
- Operation and maintenance materials
- Energy
- Chemicals

Operation and maintenance labor requirements for each unit process were recorded from all data sources in terms of manhours per year. A labor rate of 20 dollars per manhour, including fringe benefits and plant overhead, was used to convert the manhour requirements into an annual cost.

Operation and maintenance material costs account for the replacement, repair, and routine maintenance of all equipment associated with each unit process. Material costs were developed solely from data reported in the literature.

Electrical energy requirements for process equipment were tabulated in terms of kilowatt-hours per year. The cost of electricity used is 4.0 cents per kilowatt-hour, based on the average value of electricity costs as reported in the aluminum forming category data collection portfolios. Fuel oil and natural gas costs used were also obtained from the data collection portfolios. The average fuel oil cost was 26 cents per therm and the average natural gas cost was 22 cents per therm.

Chemicals used in the treatment processes presented in this section are sulfuric acid and caustic for pH adjustment, hydrated lime for heavy metals precipitation, sulfur dioxide for hexavalent chromium reduction, and alum and polymer for emulsion breaking.

Although not included in the annual cost equations, amortization, depreciation, and sludge disposal are considered in the plant-by-plant cost analysis. See the example which follows in this section.

Capital costs are amortized over a 10-year period at 12 percent interest. The corresponding capital recovery factor is 0.177. The annual cost of depreciation was calculated on a straight line basis over a 10-year period. The costing methodology resulted in double-counting the value for depreciation. The annual cost estimates were corrected by subtracting 10 percent of the capital cost from the annual cost.

Many of the unit processes chosen as treatment technologies produce a residue or sludge that must be discarded. Sludge disposal costs presented in this section are based on charges made by private contractors for sludge hauling services. Costs for hauling vary with a number of factors including quantity of sludge to be hauled, distance to disposal site, disposal method used by the contractor, and variation in landfill policy from state to state. Costs for contractor hauling of sludges are based on data collected in the development of effluent guidelines for the paint industry in which 511 plants reported contractor hauling information.

A cost of 30 cents per gallon was used for the paint guideline development as a sludge hauling and landfilling cost and is used in this report. This value is conservative since many sludges hauled in the paint industry are considered hazardous wastes and require more expensive landfilling facilities relative to landfill facilities required for nonhazardous wastes.

Cost Data Reliability

To check the validity of the capital cost data, the capital costs developed for this category were compared to capital costs reported in the data collection portfolios. As stated earlier, the cost information reported in the data collection portfolios was for treatment systems rather than individual unit processes and therefore was not used to develop costs for existing treatment facilities in the aluminum forming category.

Nineteen plants reported treatment system capital cost information. The total reported capital cost for all 19 facilities is equal to $3,600,000. The sum of the cost estimates developed with the costing methodology described herein for the same 19 treatment systems is equal to $4,300,000. Although variations at individual plants were occasionally much greater, the overall difference of capital costs was 19 percent. Detailed design parameters (i.e., retention times, chemical dosages, etc.) for the data collection portfolio treatment systems were seldom reported. Therefore, the costs developed in this section are based on one set of design parameters which may differ from the design parameters actually used at the 19 plants which reported cost information. This could result in large variances at individual facilities, but the effect of the possible design differences is dampened when a large number of facilities are considered as is indicated by the 19 percent difference in costs for the 19 treatment systems studied.

Treatment Technologies and Related Costs

Costs have been determined for the following wastewater treatment and sludge disposal technologies to be used in the various treatment alternatives:

- Skimming

- Chemical emulsion breaking
- Dissolved air flotation
- Thermal emulsion breaking
- Multimedia filtration
- pH adjustment
- Lime and settle (L&S)
- Hexavalent chromium reduction
- Cyanide oxidation
- Cyanide precipitation
- Activated carbon adsorption
- Vacuum filtration
- Contractor hauling
- Countercurrent cascade rinsing
- Regeneration of chemical baths

Costs have also been determined for the following items which relate to the operation of a treatment plant:

- Flow equalization
- Pumping
- Holding tank
- Recycle
- Monitoring

A discussion of the design parameters used and major and auxiliary equipment associated with each treatment technology and related items is contained below.

Skimming. Skimming is included as a wastewater treatment option to remove free oils commonly found in aluminum forming plants. The equipment used as the basis for developing capital and annual costs for skimming are as follows:

- Gravity separation basin
- Oil skimmer
- Bottom sludge scraper

It is assumed that the oil to be removed has a specific gravity of 0.85 and a temperature of 20°C. Sludge quantities, in terms of gallons of sludge per 1,000 gallons of wastewater generated, are tabulated in Table VIII-3, based on sampling data. The basis for energy requirements is the use of a 1/2-HP motor for skimming based on 100 gal/hr of oil. Figure VIII-4 presents capital and annual costs of oil skimming.

Chemical Emulsion Breaking. Alum and polymer addition to wastewater aids in the separation of oil from water, as discussed in Section VII (p. 736). To determine the capital and annual costs, 400 mg/l of alum and 10 mg/l of polymer are assumed to be added to waste streams containing such emulsified oils as spent rolling emulsions. The equipment included in the capital and annual costs are as follows:

- Chemical feed system
  1. Storage units
  2. Dilution tanks
  3. Conveyors and chemical feed lines
  4. Chemical feed pumps
- Rapid mix tank (detention time, 5 minutes)
  1. Tank
  2. Mixer
  3. Motor drive unit
- Skimming
  1. Gravity separation basin
  2. Surface skimmer
  3. Bottom sludge scraper

Costs were derived based on a composite of various systems which included the above equipment. Alum and polymer costs were obtained from vendors: dry alum at $0.15 per pound and polymer at $3.00 per pound. Energy requirements were also composited from various literature sources to be included in the annual costs. Capital and annual costs for chemical emulsion breaking are presented in Figure VIII-5.

Dissolved Air Flotation. Dissolved air flotation (DAF) can be used by itself, in conjunction with gravity separation for the removal of free oil, or also in conjunction with coagulant and flocculant addition to increase oil removal efficiency. The capital and annual cost equations in Table VIII-2 provide costs only for the dissolved air flotation unit; other systems, such as flocculant addition, may be added in separately.

The equipment used to develop capital and annual costs (Figure VIII-6) for the DAF system is as follows:

- Flotation unit
- Surface skimmer
- Bottom sludge scraper
- Pressurization unit
- Recycle pump
- Electrical and instrumentation
- Concrete pad, 1 ft. thick

a recycle ratio of 30 percent. All costs and energy requirements were derived as composites of various sytems presented in the literature. Energy requirements are estimated to range from 54,000 Kw-hr/yr at 30,000 GPD to 35,000,000 Kw-hr/yr at 10 MGD. Below 30,000 GPD flowrate, energy requirements are considered to be constant.

Thermal Emulsion Breaking. Thermal emulsion breaking is used to treat spent emulsion wastes potentially yielding a salable oil by-product. The system and its components which were costed for this technology is described in detail in Section VII. Standard "off the shelf" thermal emulsion breaking systems were costed. The Agency believes that custom design to account for site-specific requirements might significantly reduce the overall cost. A separate boiler was costed for heat supply to the unit. Equipment sizing was based on continuous operation. Influent oil concentration was assumed to be 5 percent and the effluent, 80 percent. For economic assessment purposes, a credit of $0.20 per gallon of treated oil was assumed. Capital and annual costs of thermal emulsion breaking are presented on Figure VIII-7.

In determining annual costs, the energy requirements were calculated using 1.5 pounds of steam per pound of water evaporated. In practice, low-grade waste heat may be available to support the thermal emulsion breaking process. To be conservative, however, capital and annual costs include the boiler operation. The usage of energy was found to range from 8,500 therms/year at 150 GPD to 680,000 therms/year at 12,000 GPD.

Multimedia Filtration. Multimedia filtration is used as a wastewater treatment polishing device to remove suspended solids not removed in previous treatment processes. The filter beds consist of graded layers of gravel, coarse anthracite coal, and fine sand. The equipment used to determine capital and annual costs (Figure VIII-8) are as follows:

- Filter tank and media
- Surface wash system
- Backwash system
- Valves
- Piping
- Controls
- Electrical system

The filters were sized based on a hydraulic loading rate of 4 gpm/ft^2 and pumps were sized based on a backwash rate of 16 gpm/ft^2. All costs and energy requirements were derived as a composite of a variety of literature sources and vendor contacts. Energy requirements for the filtration operation are estimated to range from 300 Kw-hr/yr at 1,000 GPD to 300,000 Kw-hr/yr at 10

MGD. Energy requirements are constant between 1,000 GPD and 10,000 GPD.

pH Adjustment. The adjustment of pH is particularly important for treatment of wastewater streams such as cleaning or etching streams. Sulfuric acid and caustic are used as the chemical agents for addition to the wastewater stream. The following equipment are used in determining capital and annual costs:

- Chemical feed system
  - Bulk storage tank
  - Dry tank
  - Mixer
  - Flow regulator
- Concrete tank (detention time, 15 minutes)
- Mixing equipment
- Instrumentation
- Sump pump

Operating costs are based on the following assumptions:

- Sulfuric acid dose rate of 0.5 pound per 1,000 gallons of wastewater.
- Caustic dose rates of 0.5, 5, and 20 pounds per 1,000 gallons of wastewater.
- Caustic (NaOH) cost of $175 per ton for 50 percent solution (Chemical Marketing Reporter).
- Sulfuric acid cost of $41 per ton for 63 percent solution (Chemical Marketing Reporter).

Labor and energy costs were assumed to be equal for all alkali and acid dose rates. Energy requirements on a system basis are linear from 10,000 GPD to 500,000 GPD at 660 Kw-hr/yr and increase to 14,000 Kw-hr/yr at 10 MGD.

Capital and annual costs for pH adjustment with acid are presented on Figure VIII-9, pH adjustment with caustic are presented on Figure VIII-10.

Lime and Settle (L&S). Quicklime (CaO) or hydrated lime [$Ca(OH)_2$] can be used to precipitate heavy metals. Hydrated lime is commonly used for wastewaters with low lime requirements since the use of slakers, required for quicklime usage, is practical only for large-volume application of lime. Wastewater sampling data were analyzed to determine lime dosage requirements and sludge production for those waste streams in the aluminum forming category that contain heavy metals selected as pollutants. The results of this analysis are tabulated in Table VIII-4. Due to the low lime dosage requirements in this industry, hydrated lime is used for costing.

The pH of waste streams treated with lime precipitation may require readjustment before discharge. Sulfuric acid is used to adjust the pH to an acceptable discharge level (pH 6 to 9). Thus, hydrated lime, sulfuric acid storage and feed systems, and a clarifier are included in the lime and settle capital and annual costs. Optional treatment systems which have been costed separately and which may be used in conjunction with the above lime and settle systems are a polymer feed system and flocculator.

The following equipment were included in the determination of capital and annual costs (Figure VIII-11) based on continuous operation:

- Lime feed system
    - Storage units
    - Dilution tanks
    - Feed pumps

- Acid neutralization system
    - Storage units
    - Mixer
    - Flow regulator
    - Instrumentation

Other annual cost bases are as follows:

- Lime dosage rates include 200 mg/l and 2,000 mg/l.

- Hydrated lime cost of $35.75 per ton (Chemical Marketing Reporter).

The lime dosage was selected based on raw wastewater characteristics. Those waste streams with low contaminant levels required 200 mg/l of lime. Those with higher contaminant levels required 2,000 mg/l. The lime dosages used for each waste stream are summarized in Table VIII-4.

Cost equations are presented for both of the above lime dosage rates. All cost equations and energy requirements for lime and settle were based on composited values of various systems. Energy requirements which were found to vary with flowrate are estimated to range from 2,000 Kw-hr/yr at 1 GPM to 225,000 Kw-hr/yr at 10,000 GPM.

Hexavalent Chromium Reduction. Chromium present in aluminum forming wastewaters is considered to be in the hexavalent state. The addition of sulfur dioxide at low pH values reduces hexavalent chromium to trivalent chromium, which forms a precipitate. The equipment included in the capital and annual costs are as follows:

- Reaction vessel (detention time, 45 minutes)
- Sulfuric acid storage and feed system
- Sulfonator
- Oxidation reduction potential meter
- Associated pressure regulator and appurtenances

This system has been costed both on a continuous and batch basis. The composite-based capital cost equations presented in Table VIII-2 include batch operation for flows greater than 0.2 gpm and less than 20 gpm. Above 20 gpm, the system is continuous. Capital and annual costs for chromium reduction are presented on Figure VIII-12.

Operation and maintenance costs include labor, chemicals, and repair parts. The labor rate used is $20.00 per manhour; it is estimated that supply and labor costs contribute equally to the O&M cost.

Energy requirements include electricity for pumps, mixers, and monitors. The combined energy requirement for this equipment was determined to be constant over the range of flowrates at 9,480 Kw-hr/yr.

Cyanide Oxidation. In this technology, cyanide is destroyed by reaction with sodium hypochlorite under alkaline conditions. A complete system for this operation includes reactors, sensors, controls, mixers, and chemical feed equipment. Control of both pH and chlorine concentration through oxidation reduction potential (ORP) is important for effective treatment.

Capital costs for cyanide oxidation as shown in Table VIII-2 include reaction tanks, reagent storage, mixers, sensors, and controls necessary for operation. Costs are estimated for both batch and continuous systems, with the operating mode selected on a least cost basis. Specific costing assumptions are as follows:

For both continuous and batch treatment, the cyanide oxidation tank is sized as an above-ground cylindrical tank with a retention time of four hours based on the process flow. Cyanide oxidation is normally done on a batch basis; therefore, two identical tanks are employed. Cyanide is removed by the addition of sodium hypochlorite with sodium hydroxide added to maintain the proper pH level. A 60-day supply of sodium hypochlorite is stored in an in-ground covered concrete tank, 0.3 m (1 ft) thick. A 90-day supply of sodium hydroxide also is stored in an in-ground covered concrete tank, 0.3 m (1 ft) thick.

Mixer power requirements for both continuous and batch treatment are based on 2 horsepower for every 11,355 liters (3,000 gal) of tank volume. The mixer is assumed to be operational 25 percent of the time that the treatment system is operating.

A continuous control system is costed for the continuous treatment alternative. This system includes:

- 2 immersion pH probes and transmitters
- 2 immersion ORP probes and transmitters
- 2 pH and ORP monitors
- 2 2-pen recorders
- 2 slow process controllers
- 2 proportional sodium hypochlorite pumps
- 2 proportional sodium hydroxide pumps
- 2 mixers
- 3 transfer pumps
- 1 maintenance kit
- 2 liquid level controllers and alarms and miscellaneous electrical equipment and piping

A complete manual control system is costed for the batch treatment alternative. This system includes:

- 2 pH probes and monitors
- 1 mixer
- 1 liquid level controller and horn
- 1 proportional sodium hypochlorite pump
- 1 on-off sodium hydroxide pump and PVC piping from the chemical storage tanks

Operation and maintenance costs for cyanide oxidation include labor requirements to operate and maintain the system, electric power for mixers, pumps, controls, and treatment chemicals. Labor requirements for operation are substantially higher for batch treatment than for continuous operation. Maintenance labor requirements for continuous treatment are fixed at 150 manhours per year for flow rates below 23,000 gph and thereafter increase according to:

Labor = .00273 x (Flow - 23,000) + 150

Maintenance labor requirements for batch treatment are assumed to be negligible.

Annual costs for treatment chemicals are determined from cyanide concentration, acidity, and flow rates of the raw waste stream according to:

lbs sodium hypochlorite = 62.96 x lbs CN

Capital and annual costs for cyanide oxidation are presented in Figure VIII-13.

Cyanide Precipitation. Cyanide precipitation is a two stage process to remove free and non-complexed cyanide as a precipitate. For the first step, the wastewater is contacted with an excess of $FeSO_4.7H_2O$ at pH 9.0 to ensure that all cyanide is converted to the complex form:

$$FeSO_4 \bullet 7H_2O + 6\ CN^- \qquad Fe(CN)_6{}^{4-} + 7H_2O$$

The hexacyanoferrate is then routed to the second stage, where additional $FeSO_4\ .\ 7H_2O$ and acid are added to lower the pH to 4.0 or less, causing the precipitation of $Fe_4(Fe(CN)_6)_3$ (Prussian blue) and its analogues:

$$4\ FeSO_4 \bullet 7H_2O + 3\ Fe((N)_6{}^{4-} \qquad pH \leq 4.0$$
$$Fe_4\ (Fe(CN)_6)_3 + 7H_2O$$

The blue precipitate is settled and the clear overflow is discharged for further treatment.

The cyanide precipitation system includes chemical feed equipment for sodium hydroxide, sulfuric acid, and ferrous sulfate addition, a reaction vessel, agitator, control system, clarifier, and pumps.

Costs can be estimated for both batch and continuous systems with the operating mode selected on a least cost basis. This decision is a direct function of flowrate. Capital costs are composed of five subsystem costs: (1) $FeSO_4$ feed system, (2) NaOH feed system, (3) reaction vessel with agitator, (4) sulfuric acid feed system, (5) clarifier, and (6) recycle pump. These subsystems include the following equipment:

(1) Ferrous sulfate feed system

- ferrous sulfate steel storage hoppers with dust collectors (largest hopper size is 6,000 ft^3; 15

days storage)
- enclosure for storage tanks
- volumetric feeders (small installations)
- mechanical weigh belt feeders (large installations)
- dissolving tanks (5 minute detention time, 6 percent solution)
- dual-head diaphragm metering pumps
- instrumentation and controls

(2a) Caustic feed system (less than 200 lb/day usage)

- volumetric feeder
- mixing tank with mixer (24-hour detention, 10 percent solution)
- feed tank with mixer (24-hour detention)
- dual-head metering pumps
- instrumentation and controls

(2b) Caustic feed system (greater than 200 lb/day usage)

- storage tanks (15 days, FRP tanks)
- dual-head metering pumps including standby pump
- instrumentation and controls

(3) Reaction tank (60 minutes detention time, stainless steel, agitator mounting, agitator, concrete slab)

(4) Sulfuric acid feed system (93 percent H_2SO_4)

- acid storage tank (15 days retention)
- chemical metering pump
- instrumentation and control

(5) Clarifier [based on 700 GPD/ft^2; to include a steel or concrete vessel (depending on flow rate), support structure, sludge scraper assembly and drive unit]

(6) Recycle pumps (for sludge or supernatant)

Operation and maintenance costs for cyanide precipitation include labor requirements to operate and maintain the system, electric power for mixers, pumps, clarifier and controls, and treatment chemicals. Electrical requirements are also included for the chemical storage enclosures for lighting and ventilation and in the case of caustic storage, heating. The following criteria are used in establishing O&M costs:

(1) Ferrous sulfate feed system

- maintenance materials - 3 percent of manufactured

equipment cost
- labor for chemical unloading
  - --5 hrs/50,000 lb for bulk handling
  - --8 hrs/16,000 lb for bag feeding to the hopper
  - --routine inspection and adjustment of feeders is 10 min/feeder/shift
- maintenance labor
  - --8 hrs/yr for liquid metering pumps
  - --24 hrs/yr for solid feeders and solution tank
- power [function of instrumentation and control, metering pump HP and volumetric feeder (bag feeding)]

(2) Caustic feed system

- maintenance materials - 3 percent of manufactured equipment cost (excluding storage tank cost)
- labor/unloading
  - --dry NaOH - 8 hrs/16,000 lb
  - --liquid 50 percent NaOH - 5 hrs/50,000 lb
- labor operation (dry NaOH only) - 10 min/day/feeder
- labor operation for metering pump - 15 min/day
- annual maintenance - 8 hrs
- power includes metering pump HP, instrumentation and control, volumetric feeder (dry NaOH)

(3) Reaction vessel with agitator

- maintenance materials - 2 percent of equipment cost
- labor
  - --15 min/mixer/day routine O&M
  - --4 hrs/mixer/6 mos - oil changes
  - --8 hrs/yr - draining, inspection, cleaning
- power - based on horsepower requirements for agitator

(4) Sulfuric acid feed system

- labor unloading - .25 hr/drum acid
- labor operation - 15 min/day
- annual maintenance - 8 hrs
- power (includes metering pump)
- maintenace materials - 3 percent of capital cost

(5) Clarifier

- maintenance materials range from 0.8 percent to 2 percent as a function of increasing size
- labor - 150 to 500 hrs/yr (depending on size)
- power - based on horsepower requirements for sludge

pumping and sludge scraper drive unit

(6) Recycle pump

- maintenance materials - percent of manufactured equipment cost variable with flowrate
- 50 ft TDH; motor efficiency of 90 percent and pump efficiency of 85 percent

Annual costs for treatment chemicals are determined from cyanide concentration, pH, metals concentrations, and flowrate of the raw waste stream.

Activated Carbon Adsorption. Activated carbon is used primarily for the removal of organic compounds from wastewater. The capital and annual costs for this process are based on a system using granular activated carbon (GAC) in a series of downflow contacting columns. Separate cost equations are presented for GAC contacting units and GAC replacement.

Two methods of replacing spent carbon were considered: (1) thermal regeneration of spent carbon and (2) replacement of spent carbon with new carbon and disposal of spent carbon. Thermal regeneration of spent activated carbon is economically practical only at relatively large carbon exhaustion rates. Simply replacing spent carbon with new carbon is more practical than thermal regeneration for plants with low carbon usage.

An analysis was performed to determine the carbon usage rate at which thermal regeneration of spent carbon becomes practical. It was determined that thermal regenerating facilities are practical above a carbon usage of 400,000 lbs per year. Carbon exhaustion rates for all waste streams are presented in Table VIII-5. Data from the literature were analyzed to determine a relationship between TOC concentration and carbon exhaustion rate. These data were applied to sampling data to obtain the carbon exhaustion rates shown in Table VIII-5.

A 30-minute empty-bed contact time was used to size the downflow contacting units. The activated carbon used in the columns was assumed to have a bulk density of 26 pounds per cubic foot and cost 53 cents per pound. Included in the capital for a carbon contacting system are carbon contacting columns, initial carbon fill, carbon inventory and storage backwash system, and wastewater pumping.

Thermal regeneration is assumed to be accomplished with multiple hearth furnaces at a loading rate of 40 pounds of carbon per square foot of hearth area per day. Activated carbon thermal regeneration facilities include a multiple hearth furnace, spent carbon storage and dewatering equipment, quench tank, screw conveyors, and regenerated carbon refining and storage tanks.

Energy requirements for activated carbon systems are two-fold: heating for thermal regeneration (above 400,000 lbs carbon used per year) and electricity. The Btu requirements for heating range from 1×10^{10} Btu/yr at 400,000 lbs carbon to 2.1×10^{11} Btu/yr at 30×10^{6} lb carbon. Electrical requirements are from 250,000 Kw-hr/yr at 200,000 lbs carbon up to 1.5×10^{6} Kw-hr/yr at 30×10^{6} lbs carbon.

Capital and annual costs for activated carbon adsorption are presented on Figure VIII-14.

Vacuum Filtration. Vacuum filtration is a technology utilized in sludge dewatering. This system is included in the wastewater treatment train depending on the amount of sludge generated from precipitation systems. Per the discussion presented in the costing example, vacuum filtration is costed if sludge generation exceeds 140,000 gallons per year. Below this value, it is not economically attractive to dewater the sludge prior to disposal.

Capital costs are based on the area of filter required, or a solids loading rate of 4 pounds per hour per square foot, and an operating period of six hours per day. The equipment included in the vacuum filtration unit are as follows:

- Motor and drive
- Auxiliaries
- Piping and ductwork
- Instrumentation
- Electrical
- Insulation
- Paint
- Accessories
- Vacuum system

A minimum capital cost of $66,000 is assumed. Annual costs were developed in terms of the amount of sludge to be dewatered. The assumed influent suspended solids concentration is 7 percent and the effluent, 30 percent. Energy requirements are based on filter size and flow rate, as in the case of capital costs. These are estimated to range from 45,000 kw-hr/yr for 100 ft^2 filter area to 268,000 kw-hr/yr for 960 ft^2.

Capital and annual costs for vacuum filtration are presented in Figure VIII-15.

Contract Hauling. As stated previously, information obtained from 511 plants in an EPA Effluent Guidelines Division study of the paint industry was used to determine contractor hauling costs. Costs in the paint study ranged from 1 cent to over 50 cents per gallon. A value of 30 cents per gallon, selected as a reasonable estimate in the paint study, was used in the development of the aluminum forming guidelines for the disposal cost of sludge and wastewater by contractor hauling. The cost of contract hauling is presented in Figure VIII-16.

Countercurrent Cascade Rinsing. Countercurrent cascade rinsing is a technique used to reduce wastewater flows from rinsing operations. This technology has been described in detail in Section VII (p. 775).

Capital costs are based on the number of tanks needed to achieve a required flow reduction, and pumping if water cannot be moved between the tanks by gravity flow. Each tank is assumed to be rectangular, of dimensions 15 feet by 5 feet, by 8 feet deep. Capital cost estimating for countercurrent cascade rinsing systems is highly site-specific. Tank sizing, in particular cross-sectional area, may be determined by or limited by the cross-sectional area of the workpiece. No piping costs are included since it is assumed that pumping will not be necessary. Final rinse stage tanks can be easily raised, or variable height overflow weirs can be installed in a single large tank to allow gravity flow of the rinse water. No retrofit land costs are included. Based on plant visits to 22 aluminum forming sites, the Agency believes that there is enough floor space for installation of countercurrent cascade rinsing operations at existing plants.

The capital expenditure involved in installing countercurrent cascade rinsing technology will be in part offset by reduced water use and sewer fees, and the overall reduction in the size of the required waste treatment system, which is designed on the basis of volumetric flow.

There are no significant operation and maintenance costs associated with tanks so the annual cost estimates include only annual depreciation and amortization.

Regeneration of Chemical Baths. Bath regeneration is used to recover or replenish the bath chemicals, reduce contaminant levels in the bath, and to achieve zero discharge. As discussed in Section VII (p. 779), regeneration of chromic acid and sulfuric acid baths is accomplished through periodic addition of solid chromic acid or sulfuric acid. Salts formed in the bath constantly precipitate and must be drawn off the bottom of the tank. In general, there are no additional capital costs required for equipment to regenerate these types of baths. Removal of settled precipitates is accomplished by existing pumping equipment used for emptying the bath in plants not currently regenerating baths. Chemical costs associated with regeneration were costs for replenishing chromic acid and sulfuric acid.

For caustic baths, addition of lime and elevation of the bath temperature is required for regeneration. The Agency assumed that plants have sufficient waste heat available to elevate the bath temperature. Chemical costs associated with regeneration of caustic baths were costs for lime.

The capital expenditures required for recovering and reusing alkaline cleaning bath chemicals was the cost of an ultrafiltration system. Membrane life was assumed to be one year as a result of discussions with equipment manufacturers. The cost of the membranes was assumed to be $100 per membrane. One hour per week was used for maintenance labor. Alkaline cleaning chemicals were assumed to cost $0.50 per pound. In addition, the ultrafilter was assumed to be washed with a cleaner, one time each week. The cleaner cost was assumed to be $2.00 per pound.

In considering the costs discussed above associated with regeneration, EPA concluded that the costs incurred will be offset by decreased chemicals cost through recovery, reduced water use and sewer fees, the overall reduction in the size of the required treatment system, and the reduced labor requirements for maintaining the baths.

Flow Equalization. Flow equalization is used in order to minimize potentially wide fluctuations in raw wastewater flow and characteristics. Equalization has been included in the costs associated with each treatment option presented.

The equipment included in the capital and annual costs is an equalization tank with associated mixing equipment. The detention time assumed is four hours. For this technology, capital and annual costs (Figure VIII-17) were derived by compositing various system costs from the literature. Energy requirements are expected to range from 2,500 Kw-hr/yr at 1 gpm to 300,000 Kw-hr/yr at 10,000 gpm.

Pumping. The cost of pumping raw wastewater to a treatment plant was considered, as was the cost for a dry well enclosure of the pumping facility. Costs for wet wells have not been considered since the equalization basin for treatment plant operation can function as a wet well. The pump station electrical requirements are based on a total dynamic head of 30 feet and a pumping efficiency of 65 percent. These requirements are estimated to range from 54 Kw-hr/yr for 1,000 gpd to 550,000 Kw-hr/yr for 10 MGD flowrate.

Capital and annual costs for pumping are presented in Figure VIII-18.

Holding Tank. The cost of holding tanks has been considered for the storage of sludges removed from skimming, dissolved air flotation, and lime and settle operations. The equations can also be used for the storage of dewatered sludge cake. Allowances are made for storage of two weeks of sludge production to a minimum of 150 gallons for sludges requiring contractor hauling.

Capital and annual costs for holding tanks are presented in Figure VIII-19.

Recycle of Cooling Water. As discussed in Section VII (p. 772), direct chill casting contact cooling water is commonly recycled at rates of 96 percent or greater. For those plants that do not recycle direct chill casting contact cooling water, the cost of recycle has been determined. Recycle capital costs include a cooling tower, a pump station, and piping. The capital costs for a cooling tower assume the use of a mechanical draft tower. The sizing of the tower is based on a temperature range of 25°F, an approach of 10°F, and a wet bulb temperature of 70°F. The cooling tower equipment include the following:

- Cooling tower
- Basin
- Handling and setting (installation)
- Piping
- Concrete foundations and footings
- Instrumentation
- Plant mechanical draft system
- Accessories

A minimum cost is assumed to be $62,000. Energy requirements are a function of the fan size and horsepower required, depending on recirculation ratio. These requirements are estimated to range from 14,600 Kw-hr/yr at 0.1 MGD to 1,460,000 Kw-hr/yr at 10 MGD.

To account for recycle piping requirements, costs have been determined for 1,000 feet of installed force main. Capital costs for recycle piping include the following:

- Concrete-lined ductile iron pipe

- 3, 4, 8, 12, 16, or 24 inch pipe diameters

- 0, 10, 20, or 40 ft. static heads

- 3 feet per second water velocity

- Pipe fittings
  - 3 gate valves
  - 1 standard tee
  - 4 long sweep elbows
- Installation with excavation and backfill (below ground)

Energy requirements for pumping are the same as those given above in the pumping discussion.

Capital and annual costs associated with recycling are presented in Figure VIII-20.

Enclosures. The cost of an enclosure is included in the capital cost equations for all unit processes except skimmming, equalization, lime and settle (lime and sulfuric acid storage and chemical feed systems are enclosed) and the cooling tower associated with recycle since the performance of these unit processes is not typically affected by inclement weather. The cost of enclosure includes the following:

- Roofing
- Insulation
- Sitework
- Masonry
- Glass
- Plumbing
- HVAC and electrical

The total capital cost is calculated by determining the required area to be enclosed and applying $30 per square foot.

Cost Calculation Example

Capital and annual costs for each of the treatment alternatives presented in Sections X and XII can be estimated both from the cost equations in Table VIII-2 and, depending on the alternative, from the data on oily sludge production, lime dosage and lime sludge production, and carbon exhaustion rate shown in Tables VIII-3 through VIII-5. Once the wastewater flows are determined, the costs associated with a treatment alternative are calculated systematically using the following steps.

1. Determine capital and annual costs for each of the treatment processes in the alternative using Table VIII-1.

2. Determine capital and operating costs for pumping,

equalization, and monitoring using Table VIII-1.

3. Calculate daily production, if any, of oily sludge and lime sludge from Tables VIII-3 and VIII-4. Determine the costs associated with the disposal of these residues using Table VIII-2.

4. Determine total capital and annual costs for the alternative by summing up all cost data obtained in Steps 1 through 3. The annual cost so determined does not include amortization and depreciation of capital investment. Obtain the total annual cost by including 17.7 percent and 10 percent of the capital cost for amortization and depreciation, respectively.

As described previously, capital and operating costs associated with the lime and settle (L&S) and activated carbon processes are influenced by the lime dosage and carbon replacement requirements, respectively. Therefore, Tables VIII-3 and VIII-4 should be consulted first to determine lime dosage for the particular wastewater stream under consideration or to evaluate the economic choice between thermal regeneration and throwaway of spent carbon for the activated carbon process.

Disposal of lime sludge is based on vacuum filtration, with the resulting cake hauled by contractor or contractor-hauling of undewatered liquid sludge. The economic choice between these two methods depends upon the quantity of sludge requiring disposal, with the dividing line being approximately 140,000 gallons per year. Direct contractor-hauling of liquid sludge is less expensive for smaller sludge quantities, while the opposite is true for greater sludge quantities. The cost components for the former are holding tank capital cost (minimum capacity, 150 gallons) and contractor-hauling cost, while those for the latter are holding tank capital cost (both for liquid sludge and cake), vacuum filtration cost, and contractor-hauling cost for cake. The cost components for oily sludge disposal are holding tank capital cost (minimum capacity, 150 gallons) and contractor-hauling cost.

The cost calculating procedures described above are illustrated for a plant in the Forging Subcategory with the following conditions:

Wastewater source: Forging solution heat treatment contact cooling water
Operating time: 24 hours per day, 7 days per week, 52 weeks per year
Wastewater flow: 200 gallons per minute
Treatment alternative: BPT consisting of (1) cyanide

oxidation, (2) chromium reduction, (3) skimming, and (4) lime and settle (see Figure IX-4)

Step 1:

Determine the capital and annual costs of the three treatment processes shown above using appropriate equations in Table VIII-2. For example, the capital cost (C) of chromium reduction for a flow (x) of 200 gpm can be calculated as:

$$\begin{aligned} C &= \text{antilog}\ [-0.0248\ (\log 200)^{3}] + 0.108\ (\log 200)^{2} + \\ &\quad 0.213\ (\log 200) + 4.107 + 384.8\ (200)^{0.67} \\ &= \text{antilog}\ (4.86) + 13{,}390 \\ &= 86{,}000 \end{aligned}$$

The forging solution heat treatment contact cooling water stream requires 2,000 mg/l lime dosage for precipitation (Table VIII-4); use cost equations for lime and settle corresponding to this dosage. A summary of Step 1 costs is shown below.

	Capital	Annual ($/yr)
Cyanide oxidation	166,000	17,000
Chromium reduction	86,000	10,000
Skimming	55,000	10,000
Lime and settle	221,000	63,000
Subtotal	528,000	100,000

Step 2:

Capital and annual costs are calculated for flow equalization, pumping, and monitoring. By using the appropriate equations in Table VIII-2, the following costs are obtained for flow equalization and pumping. Monitoring costs are constant at a capital cost of $8,000 and an annual cost of $5,000.

	Capital ($)	Annual ($/yr)
Flow equalization	103,000	10,000
Pumping	31,000	14,000
Monitoring	8,000	5,000
Subtotal	142,000	29,000

Step 3:

(a) Determine daily production of oil skimmings (oily sludge) using data in Table VIII-3, required holding tank capacity, and associated disposal costs from Table VIII-2.

Oil Skimmings =

$$\frac{0.07\ \text{gallons skimmings}}{1{,}000\ \text{gallons}} \times \frac{200\ \text{gallons}}{\text{min}} \times \frac{1{,}440\ \text{min}}{\text{day}} = \frac{20\ \text{gallons}}{\text{day}}$$

As discussed previously, holding tanks are sized for two weeks' sludge production, or a minimum of 150 gallons holding tank capacity. Required holding tank capacity is:

$$\frac{20\ \text{gallons}}{\text{day}} \times \frac{7\ \text{days}}{\text{week}} \times 2\ \text{weeks} = 280\ \text{gallons}$$

The capital cost (holding tank) and annual cost (contractor hauling) for the disposal of oily sludge are then calculated as:

	Capital ($)	Annual ($/yr)
Oil skimmings disposal	2,100	2,200

(b) Determine daily production of lime sludge using data in Table VIII-4, then determine whether the sludge should be dewatered by vacuum filtration prior to disposal.

Lime sludge =

$$\frac{6\ \text{gallons sludge}}{1{,}000\ \text{gallons}} \times \frac{200\ \text{gallons}}{\text{min}} \times \frac{1{,}440\ \text{minutes}}{\text{day}} = \frac{1{,}700\ \text{gallons}}{\text{day}}$$

At 365 days per year operation, this quantity corresponds to an annual lime sludge production of 620,000 gallons. Therefore, vacuum filtration and cake hauling is more cost-effective than liquid sludge hauling.

To estimate the required size of vacuum filters and the volume of filter cake, lime sludge from the settling tank and the filter cake are assumed to contain 7 percent and 30 percent solids, respectively, and have a specific gravity of 1.0.

Vacuum filter area required must be determined before the capital cost equation for vacuum filtration in Table VIII-2 can be used. At 7 percent solids, 6 hours of operation per day and a 4 lbs/hour/sq ft loading rate, one square foot of vacuum filter area can dewater 40 gallons of sludge per day. The vacuum filter area requirement for this example is presented below:

$$\frac{1{,}700\ \text{gallons}}{\text{day}} \times \frac{1}{40\ \text{gallons/day/sq ft}} = 43\ \text{sq ft}$$

Daily production of filter cake is

$$\frac{1{,}700\ \text{gallons}}{\text{day}} \times \frac{7\%\ \text{solids}}{30\%\ \text{solids}} = \frac{400\ \text{gallons}}{\text{day}}$$

Two storage tanks are required for vacuum filtration, one to store the daily clarifier underflow to facilitate a controlled flow into the vacuum filter, and the other to store the dewatered sludge. Therefore, a 1,700-gallon storage tank is required to store daily clarifier underflow. The filter cake storage tank is sized as follows:

$$\frac{400 \text{ gallons}}{\text{day}} \times \frac{7 \text{ days}}{\text{week}} \times 2 \text{ weeks} = 5,600 \text{ gallons}$$

COST ESTIMATION METHODOLOGY: POST-PROPOSAL

Sources of Cost Data

Capital and annual cost data for the selected treatment processes were obtained from three sources: (1) equipment manufacturers, (2) literature data, and (3) cost data from existing plants. The major source of equipment costs was contacts with equipment vendors, while the majority of annual cost information was obtained from the literature. Additional cost and design data were obtained from data collection portfolios when possible.

Components of Costs

Capital Costs. Capital costs consist of two components: equipment capital costs and system capital costs. Equipment costs include: (1) the purchase price of the manufactured equipment and any accessories assumed to be necessary; (2) delivery charges, which account for the cost of shipping the purchased equipment a distance of 500 miles; and (3) installation, which includes labor, excavation, site work, and materials. The correlating equations used to generate equipment costs are shown in Table VIII-6. Capital system costs include contingency, engineering, and contractor's fees. These system costs, each expressed as a percentage of the total equipment cost, are combined into a factor which is multiplied by the total equipment cost to yield the total capital investment. The components of the total capital investment are listed in Table VIII-7.

Annual Costs. The total annualized costs also consist of a direct and a system component as in the case of total capital costs. The components of the total annualized costs are listed in Table VIII-8. Direct annual costs include the following:

- Raw materials - These costs are for chemicals used in the treatment processes, which include lime, sulfuric acid, alum, polyelectrolyte, and sulfur dioxide.
- Operating labor and materials - These costs account for

the labor and materials directly associated with operation of the process equipment. Labor requirements are estimated in terms of manhours per year. A labor rate of 21 dollars per manhour was used to convert the manhour requirements into an annual cost. This composite labor rate included a base labor rate of nine dollars per hour for skilled labor, 15 percent of the base labor rate for supervision and plant overhead at 100 percent of the total labor rate. Nine dollars per hour is the Bureau of Labor national wage rate for skilled labor during 1982.

- Maintenance and repair - These costs account for the labor and materials required for repair and routine maintenance of the equipment. Maintenance and repair costs were usually assumed to be 5 percent of the direct capital costs based on information from literature sources unless more reliable data could be obtained from vendors.

- Energy - Energy, or power, costs are calculated based on total nominal horsepower requirements (in kw-hrs), an electricity charge of $.0483/kilowatt-hour and an operating schedule of 24 hours/day, 250 days/year unless specified otherwise. The electricity charge rate (March 1982) is based on the industrial cost derived from the Department of Energy's Monthly Energy Review.

System annual costs include monitoring, insurance and amortization (which is the major component). Monitoring refers to the periodic sampling analysis of wastewater to ensure that discharge limitations are being met. The annual cost of monitoring was calculated using an analytical lab fee of $120 per wastewater sample and a sampling frequency based on the wastewater discharge rate, as shown in Table VIII-9.

Insurance cost is assumed to be one percent of the total depreciable capital investment (see Item 23 of Table VIII-7).

Amortization costs, which account for depreciation and the cost of financing, were calculated using a capital recovery factor (CRF). A CRF value of 0.177 was used, which is based on an interest rate of 12 percent, and a taxable lifetime of 10 years. The CRF is multiplied by the total depreciable investment to obtain the annual amortization costs (see Item 24 of Table VIII-8).

Cost Update Factors

All costs are standardized by adjusting to the first quarter of 1982. The cost indices used for particular components of costs are described below.

Capital Investment - Investment costs were adjusted using the EPA-Sewage Treatment Plant Construction Cost Index. The value of this index for March 1982 is 414.0.

Operation and Maintenance Labor - The Engineering News-Record Skilled Labor Wage Index is used to adjust the portion of Operation and Maintenance costs attributable to labor. The March 1982 value is 325.0.

Maintenance Materials - The producer price index published by the Department of Labor, Bureau of Statistics is used. The March 1982 value of this index is 276.5.

Chemicals - The Chemical Engineering Producer Price Index for industrial chemicals is used. This index is published biweekly in *Chemical Engineering* magazine. The March 1982 value of this index is 362.6.

Energy - Power costs are adjusted by using the price of electricity on the desired date and multiplying it by the energy requirements for the treatment module in kw-hr equivalents.

Cost Estimation Model

Cost estimation was accomplished using a computer model which accepts inputs specifying the required treatment system chemical characteristics of the raw waste streams, flow rates and treatment system entry points of these streams, and operating schedules. This model utilizes a computer-aided design of a wastewater treatment system containing modules that are configured to reflect the appropriate equipment at an individual plant. The model designs each treatment module and then executes a costing routine that contains the cost data for each module. The capital and annual costs from the costing routine are combined with capital and annual costs for the other modules to yield the total costs for that regulatory option. The process is repeated for each regulatory option.

Each module was developed by coupling theoretical design information from the technical literature with actual design data from operating plants. This permits the most representative design approach possible to be used, which is a very important element in accurately estimating costs. The fundamental units for design and costing are not the modules themselves but the components within each module, e.g., the lime feed system within the chemical precipitation module. This is a significant feature of this model for two reasons. First, it does not limit the model to certain fixed relationships between various components of each module. For instance, cost data for chemical precipitation systems are typically presented graphically as a family of curves with lime (or other alkali) dosage as a parametric function. The model, however, sizes the lime feed system as a funtion of the required mass addition rate (kg/hr) of lime. The model thus selects a feed system specifically designed for that plant. Second, this approach more closely reflects the way a plant would actually design and purchase its equipment. The resulting costs are thus closer to the actual costs that would be incurred by the facility.

Overall Structure. The cost estimation model consists of two main parts: a design portion and a costing portion. The design portion uses input provided by the user to calculate design parameters for each module included in the treatment system. The design parameters are then used as input to the costing routine, which contains cost equations for each discrete component in the system. The structure of the program is such that the entire system is designed before any costs are estimated.

The pollutants or parameters which are tracked by the model are shown in Table VIII-10.

An overall logic diagram of the computer programs is depicted in Figure VIII-1. First, constants are initialized and certain variables such as the modules to be included, the system configuration, plant and wastewater flows, compositions, and entry points are specified by the user. Each module is designed utilizing the flow and composition data for influent streams. The design values are transmitted to the cost routine. The appropriate cost equations are applied, and the module costs and system costs are computed. Figures VIII-2 and VIII-3 depict the logic flow diagrams in more detail for the two major segments of the program.

Costing Input Data. Several data inputs are required to run the computer model. First, the treatment modules to be costed and their sequence must be specified. Next, information on hours of operation per day and number of days of operation per year for the particular plant being costed is required. The flow values and characteristics must be specified for each wastewater stream entering the treatment system, as well as each stream's point of entry into the wastewater treatment system. These values will dictate the size and other parameters of equipment to be costed. The derivation of each of these inputs for costed plants in the aluminum forming category will be discussed in turn.

Choice of the appropriate modules and their sequence for a plant that is to be costed are determined by applying the treatment technology for each option (see Figures X-1 through X-5). These option diagrams were adjusted to accurately reflect the treatment system that the plant being costed would actually require. For example, if it were determined by examining a plant's dcp that sodium bichromate would not be used in the plants pickling operation, then a chromium reduction module would not be included in the treatment required for that plant. In addition, if a plant had a particular treatment module in place, that module would not be costed. Flow reduction modules were not costed for plants whose waste stream flow rates were already lower than the regulatory flows. The information on hours of operation per day and days of operation per year was obtained from the data collection portfolio of the plant being costed.

The flows used to size the treatment equipment were derived as follows: production (kkg/yr) and flow (l/yr) information was obtained from the plant's dcp, or from sampling data where possible, and a production normalized flow in liters per kkg was calculated for each waste stream. This flow was compared to the regulatory flow, also in liters per kkg, and the lower of the two flows was used to size the treatment equipment. Regulatory flow was also assigned to any stream for which production or flow data was not reported in the dcp.

The raw waste concentrations of influent waste streams used for costing were based on sampling data and the assumption that the total pollutant loading (mg/hr) in a particular waste stream is directly proportional to the production rate (kkg/hr) associated with that waste stream. The procedure used for determining the pollutant concentrations (mg/l) to be used as input to the cost model was as follows: for a given input waste stream to the model during actual costing, the average production normalized raw waste values (mg/kkg) are divided by the production normalized costing flow (l/kkg) (actual or regulatory based, whichever is lower) to obtain the pollutant concentration for costing. The underlying assumption is that the amount of pollutant generated corresponds directly with the amount of product produced. A significant result of this assumption is that the total pollutant loading (mg/hr) remains constant when in-process flow reduction techniques are used (e.g., for a stream that is reduced by a factor of two via a flow reduction measure, the pollutant concentrations will increase correspondingly by a factor of two).

Model Results. For a given plant, the model will generate comprehensive material balances for each parameter (pollutant, temperature and flowrate) tracked at any point in the system. It will also summarize design values for key equipment in each treatment module, and provide a tabulation of costs for each piece of equipment in each module, module subtotals, total equipment costs, and system capital and annual costs.

Cost Estimates for Individual Treatment Technologies

Introduction. Treatment technologies have been selected from among the larger set of available alternatives discussed in Section VII after considering such factors as raw waste characteristics, typical plant characteristics (e.g., location, production schedules, product mix, and land availability), and present treatment practices. Specific rationale for selection is addressed in Sections IX, X, XI, and XII. Cost estimates for each technology addressed in this section include investment costs and annual costs for depreciation, capital, operation and maintenance, and energy. Capital and annual costs for each technology are presented in Figures VIII-21 through VIII-30.

The specific assumptions for each wastewater treatment module are listed under the subheadings to follow. Costs are presented as a function of influent wastewater flow rate except where noted in the unit process assumptions.

Costs are presented for the following control and treatment technologies:

- Lime Precipitation and Gravity Settling,
- Vacuum Filtration,
- Flow Equalization,
- Multimedia Filtration,
- Chemical Emulsion Breaking,
- Oil Skimming,
- Chromium Reduction,
- Recycle-Cooling,
- Countercurrent Cascade Rinsing, and
- Contract Hauling.

Cyanide treatment was not costed because only two plants were found to have cyanide in their wastewaters. Additionally, plants are expected to choose chemical substitution as a means of controlling the discharge of cyanide as opposed to the installation of cyanide treatment.

Lime Precipitation and Gravity Settling. Precipitation using lime followed by gravity settling is a fundamental technology for metals removal. In practice, either quicklime (CaO) or hydrated lime ($Ca(OH)_2$) can be used to precipitate toxic and other metals. Hydrated lime is more economical for low lime requirements since the use of slakers, which are necesary for quicklime usage, are practical only for large-volume application of lime.

Lime is used to adjust the pH of the influent waste stream to a value of approximately 9, at which optimum precipitation of the metals is assumed to occur (see Section VII, page 701), and to react with the metals to form metal hydroxides. The lime dosage is calculated as a theoretical stoichiometric requirement based on the influent metals concentrations and pH. The actual lime dosage requirement is obtained by assuming an excess of 10 percent of the theoretical lime dosage. The effluent concentrations are based on the Agency's combined metals data base lime precipitation treatment effectiveness values.

The costs of lime precipitation and gravity settling were based on one of three operation modes, depending on the influent flowrate: continuous, normal batch, and "low flow" batch. The use of a particular mode for costing purposes was determined on a least (total annualized) cost basis for a given flowrate. The economic breakpoint between continuous and normal batch was estimated to be 11,800 liters/hour. Below 2,000 liters/hour, it was found that the "low flow" batch system was most economical.

For a continuous operation, the following equipment were included in the determination of capital and annual costs:

- Lime feed system (continuous)

    1. Storage units (sized for 30-day storage)
    2. Slurry mix tank (5 minute retention time)
    3. Feed pumps
    4. Instrumentation (pH control)

- Polymer feed system

    1. Storage hopper
    2. Chemical mix tank
    3. Chemical metering pump

- pH adjustment system

    1. Rapid mix tank, fiberglass (5 minute retention time)
    2. Agitator (velocity gradient is 300/second)
    3. Control system

- Gravity settling system

    1. Clarifier, circular, steel (overflow rate is 0.347 gpm/sq. ft., underflow solids is 3 percent)
    2. Sludge pumps (1), (to transfer flow to and from clarifier)

Ten percent of the clarifier underflow stream is recycled to the pH adjustment tank to serve as seed material for the incoming waste stream.

The direct capital costs of the lime and polymer feed were based on the respective chemical feed rates (dry lbs/hour), which are dependent on the influent waste stream characteristics. The flexibility of this feature (i.e., costs are independent of other module components) was previously noted in the description of the cost estimation model. The remaining equipment costs (e.g., for tanks, agitators, pumps) were developed as a function of the influent flowrate (either directly or indirectly, when coupled with the design assumptions).

Direct annual costs for the continuous system include operating and maintenance labor for the feed systems and the clarifier, the cost of lime and polymer, maintenance materials and energy costs required to run the agitators and pumps.

The normal batch treatment system (used for 2,000 liters/hour flow 11,800 liters/hour) consists of the following equipment:

- Lime feed system (batch)

  1. Slurry tank (5 minute retention time)
  2. Agitator
  3. Feed pump

- Polymer feed system

  1. Chemical mix tank
  2. Agitator
  3. Chemical metering pump

- pH adjustment system

  1. Reaction tanks (2), (8 hour retention time each)
  2. Agitators (2), (velocity gradient is 300/second)
  3. Sludge pump (1), (to transfer sludge to dewatering)
  4. pH control system

The reaction tanks used in pH adjustment are sized to hold the wastewater volume accumulated for one batch period (assumed to be 8 hours). The tanks are arranged in a parallel setup so that treatment occurs in one tank while wastewater is accumulating in the other tank. A separate gravity settler is not necessary since settling will occur in the reaction tank after precipitation has taken place. The settled sludge is then pumped to the dewatering stage.

If additional tank capacity is required in the pH adjustment system in excess of 25,000 gallons (largest single fiberglass tank capacity for which cost data were compiled), additional tanks are added in pairs. A sludge pump and agitator are costed for each tank.

The cost of operating labor is the major component of the direct annual costs for the normal batch system. For operation of the batch lime feed system, labor requirements range from 15 to 60 minutes per batch, depending on the lime feed rate (5 to 1,000 pounds/batch). This labor is associated with the manual addition of lime (stored in 50 pound bags). For pH adjustment, required labor is assumed to be one hour per batch (for pH control, sampling, valve operation, etc.). Both the pH adjustment tank and the lime feed system are assumed to require 52 hours per year (one hour/week) of maintenance labor. Labor requirements for the polymer feed system are approximately one hour/day, which accounts for manual addition of dry polymer and maintenance associated with the chemical feed pump and agitator.

Direct annual costs also include the cost of chemicals (lime, polymer) and energy required for the pumps and agitators. The costs of lime and polymer used in the model are $47.30/kkg of lime ($43/ton) and $4.96/kg of polymer ($2.25/pound), based on rates obtained from the Chemical Weekly Reporter (lime) and quotations from vendors (polymer).

For small influent flowrates (less than 2,000 liters/hour) it is more economical on a total annualized cost basis to select the "low flow" batch treatment system. The lower flowrates allow an assumption of five days for the batch duration, or holdup, as opposed to eight hours for the normal batch system. However, whenever the total batch volume (based on a five day holdup) exceeds 25,000 gallons, the maximum single batch tank capacity, the holdup is decreased accordingly to maintain the batch volume under this level. Capital and annual costs for the low flow system are based on the following equipment:

- pH adjustment system

    1. Rapid mix/holdup tank (5 days or less retention time)
    2. Agitator
    3. Transfer pump

Only one tank is required for both holdup and treatment because treatment is assumed to be accomplished during non-operating hours (since the holdup time is much greater than the time required for treatment). A lime feed system is not costed since lime addition at low application rates can be assumed to be done manually by the operator. A common pump is used for transfer of both the supernatant and sludge through an appropriate valving arrangement. Addition of polymer was assumed to be unnecessary due to the extended settling time available.

As in the normal batch case, annual costs are comprised mainly of labor costs for the low flow batch system. Labor requirements are constant at 1.5 hours per batch for operation (e.g., pH control, sampling, etc.) and 52 hours per year (one hour per week) for maintenance. Labor is also required for the manual addition of lime directly to the batch tank, ranging from 0.25 to 1.5 hours per batch depending on the lime requirement (1 to 500 pounds per batch). Annual costs also include energy costs associated with the pump and agitator.

Capital and annual costs for these three operation modes of chemical precipitation and settling (lime and settle) are presented in Figure VIII-21. The curves shown in Figure VIII-21 cannot be extrapolated beyond the points shown.

Vacuum Filtration. The underflow from the clarifier is routed to a rotary precoat vacuum filter, which dewaters the hydroxide sludge (it may also include calcium sulfate and fluoride) to a cake of 20 percent dry solids. The dewatered sludge is disposed of by contract hauling and the filtrate is recycled to the rapid mix tank as seed material for sludge formation.

The capacity of the vacuum filter, expressed as square feet of filtration area, is based on a yield value of 14.6 kg of dry solids/hr per square meter of filter area (3 lbs/hr/ft^2), with a solids capture of 95 percent. It was assumed that the filter was operated 8 hours/day.

Cost data were compiled for vacuum filters ranging from 0.9 to 69.7 m^2 (9.4 to 750 ft^2) in filter surface area. Based on a total annualized cost comparison, it was assumed that it was more economical to directly contract haul clarifier underflow streams which were less than 42 l/hr (0.185 gpm), rather than dewater by vacuum filtration before hauling.

The capital costs for the vacuum filtration include the following:

- Vacuum filter with precoat but no sludge conditioning,
- Housing, and
- Influent transfer pump.

Operating labor cost is the major component of annual costs, which also include maintenance and energy costs. Capital and annual costs of vacuum filtration are presented in Figure VIII-22.

Flow Equalization. Flow equalization is accomplished through steel equalization tanks which are sized based on a retention time of eight hours and an excess capacity factor of 1.2. Cost data were available for steel equalization tanks up to a capacity of 500,000 gallons; multiple units were required for volumes greater than 500,000 gallons. The tanks are fitted with agitators with a horsepower requirement of 0.006 kw/1,000 liters (0.03 hp/1,000 gallons) of capacity to prevent sedimentation. An influent transfer pump is also included in the equalization system.

Capital and annual costs for flow equalization are presented in Figure VIII-23.

Multimedia Filtration. Multimedia filtration is used as a wastewater treatment polishing device to remove suspended solids not removed in previous treatment processes. The filter beds consist of graded layers of gravel, coarse anthracite coal, and fine sand. The equipment used to determine capital and annual costs are as follows:

- Influent storage tank sized for one backwash volume;
- Gravity flow, vertical steel cylindrical filters with media (anthracite, sand, and garnet);
- Backwash tank sized for one backwash volume;
- Backwash pump to provide necessary flow and head for backwash operations;
- Influent transfer pump; and
- Piping, valves, and a control system.

The hydraulic loading rate is 7,335 lph/m^2 (180 gph/ft^2) and the backwash loading rate is 29,340 lph/m^2 (720 gph/ft^2). The filter is backwashed once per 24 hours for 10 minutes. The backwash volume is provided from the stored filtrate.

Effluent pollutant concentrations are based on the Agency's combined metals data base for treatability of pollutants by filtration technology.

Cartridge-type filters are costed to treat small flows (less than 1,150 liters/hour) since they are more economical compared to multimedia filters (based on a least total annualized cost comparison) at these flows. It was assumed that the effluent quality achieved by cartridge-type filters was at least the level attained by multimedia filters. The costs for cartridge-type filters are based on a two-stage filter unit, a holding tank (capacity is equal to the total batch volume of preceding batch chemical precipitation tank) and an influent transfer pump.

The majority of the annual cost is attributable to replacement of the spent cartridges which depends upon the amount of solids removed. The maximum loading for each cartridge is assumed to be 0.225 kg of suspended solids. The annual energy and maintenance costs associated with the pump are also included in the total annual costs.

Capital and annual costs for cartridge and multimedia filters are presented in Figure VIII-24.

Chemical Emulsion Breaking. Chemical emulsion breaking involves the separation of relatively stable oil-water mixtures by chemical addition. Alum, polymer, and sulfuric acid are commonly used to destabilize oil-water mixtures. In the determination of capital and annual costs based on continuous operation, 400 mg/l of alum and 2 mg/l of polymer are added to waste streams containing emulsified oil. The equipment included in the capital and annual costs for continuous chemical emulsion breaking are as follows:

- Alum and polymer feed systems:
    1. Storage units
    2. Dilution tanks
    3. Conveyors and chemical feed lines
    4. Chemical feed pumps
- Rapid mix tank (retention time of 15 minutes; mixer velocity gradient is 300/sec)
- Flocculation tank (retention time of 45 minutes; mixer velocity gradient is 100/sec)
- Pump

Following the flocculation tank, the stabilized oil-water mixture enters the oil skimming module. In the determination of capital and annual costs based on batch operation, sulfuric acid is added to waste streams containing emulsified oil until a pH of 3 is reached. The following equipment is included in the determination of capital and annual costs based on batch operation:

- Sulfuric acid feed systems
    1. Storage tanks or drums

2. Chemical feed lines
3. Chemical feed pumps

- Two tanks equipped with agitators (retention time of 8 hrs., mixer velocity gradient is 300/sec)

- Two belt oil skimmers

- Two waste oil pumps

- Two effluent water pumps

- One waste oil storage tank (sized to retain the waste oil from ten batches)

The capital and annual costs for continuous and batch chemical emulsion breaking (Figure VIII-25) were determined by summing the costs from the above equipment. Alum, polymer and sulfuric acid costs were assumed to be $.257 per kg ($.118 per pound), $4.95 per kg ($2.25 per pound) and $0.08 per kg of 93 percent acid ($.037 per pound of 93 percent acid), respectively. (See Chemical Weekly Reporter, March, 1982).

Operation and maintenance and energy costs for the different types of equipment which comprise the batch and continuous systems were drawn from various literature sources and are included in the annual costs.

The cutoff flow for determining the operation mode (batch or continuous) is 5,000 liters per hour, above which the continuous system is costed; at lower flows, the batch system is costed.

For annual influent flows to the chemical emulsion breaking system of 91,200 liters/year (24,000 gallons/year) or less, it is more economical to directly contract haul rather than treat the waste stream. The breakpoint flow is based on a total annualized cost comparison and a contract hauling rate of $.40/gallon (no credit was given for oil resale).

Oil Skimming. Oil skimming costs apply to the separation of oil-water mixtures using a coalescent plate-type separator (which is essentially an enhanced API-type oil-water separator). Coalescent plate separators were not required following batch chemical emulsion breaking since the batch tank, in conjunction with a belt type oil skimmer, served as the oil-water separation tank. The cost of the belt skimmer in this case was included as part of the chemical emulsion breaking costs.

Although the required separator capacity is dependent on many factors, the sizing was based primarily on the influent wastewater flow rate, with the following design values assumed for the remaining parameters of importance:

Parameter	Nominal Design Values
Specific gravity of oil	0.85
Operating temperature (°F)	68
Influent oil concentration (mg/l)	30,000

Extreme operating conditions, such as influent oil concentrations greater than 30,000 mg/l, or temperatures much lower than 68°F were accounted for in the sizing of the separator.

The capital and annual costs of oil skimming (Figure VIII-26) included the following equipment:

- Coalescent plate separator with automatic shutoff valve and level sensor
- Oily waste storage tanks (2-week retention time)
- Oily waste discharge pump
- Effluent discharge pump

Influent flow rates up to 159,100 l/hr (700 gpm) are costed for a single unit; flows greater than 700 gpm require multiple units.

The direct annual costs for oil skimming include the cost of operating and maintenance labor and replacement parts. Annual costs for the coalescent separators alone are minimal and involve only periodic clean out and replacement of the coalescent plates.

Chromium Reduction. This technology can be applied to waste streams containing significant concentrations of hexavalent chromium. Chromium in this form will not precipitate until it has been reduced to the trivalent form. The waste stream is treated by addition of acid and gaseous SO_2 dissolved in water in an agitated reaction vessel. The SO_2 is oxidized to sulfate while it reduces the chromium.

The equipment required for this continuous stream includes an SO_2 feed system (sulfonator), an H_2SO_4 feed system, a reactor vessel and agitator, and a pump. The reaction pH is 2.5 and the SO_2 dosage is a function of the influent loading of hexavalent chromium. A conventional sulfonator is used to meter SO_2 to the reaction vessel. The mixers velocity gradient is 100/sec.

Annual costs are as follows:

- SO_2 feed system
  1. SO_2 cost at \$0.11/kg (\$0.25/lb)
  2. Operation and maintenance labor requirements vary from 437 hrs/yr at 4.5 kg SO_2/day (10 lb SO_2/day) to 5,440 hrs/yr at 4,540 kg SO_2/day (10,000 lbs SO_2/day),
  3. Energy requirements at 570 kwh/yr at 4.5 kg SO_2/day (10 lbs SO_2/day) to 31,000 kwh/yr at 4,540 kg SO_2/day (10,000 lbs SO_2/day).

- H_2SO_4 feed system

  1. Operating and maintenance labor at 72 hrs/yr at 37.8 lpd (10 gpd) of 93 percent H_2SO_4 to 200 hrs/yr at 3,780 lpd (1,000 gpd),
  2. Maintenance materials at 3 percent of the equipment cost,
  3. Energy requirements for metering pump and storage heating and lighting.

- Reactor vessel and agitator

  1. Operation and maintenance labor at 120 hrs/yr,
  2. Electrical requirements for agitator.

Capital and annual costs of chromium reduction are presented in Figure VIII-27.

Cooling Towers/Tanks. Cooling towers are used to recycle direct chill casting and solution heat treatment contact cooling waters for recirculating flow rates above 3,400 l/hr (15 gpm). The minimum flow rate represents the smallest cooling tower commercially available from the vendors contacted. Conventional holding tanks are used to recycle flow rates less than 15 gpm.

The required cooling tower capacity is based on the amount of heat removed, which takes into account both the flow rate and temperature range (decrease in cooling water temperature). The recirculation flow rate through the cooling tower is based on the BPT (option 1) flow allowance, and the bleed stream which enters the treatment system is based on the BAT (Option 2) flow allowance. For solution heat treatment cooling water, this results in a recycle rate of 73.6 percent (e.g., 7705 l/kkg - 2037 l/kkg/ 7705 l/kkg). A recycle rate of 85 percent was assumed for cooling of direct chill casting cooling water since recycle is a BPT technology for this waste stream. The range was based on a cold water temperature of 85°F and an average hot water temperature for each particular waste stream calculated from sampling data. When the hot water temperature was not available from sampling data, or found to be below 95°F, a value of 95°F was assumed, resulting in a range of 10oF (95-85oF). The remaining significant design parameters, the wet bulb temperature (ambient temperature at 100 percent relative humidity) and the approach (of cold water temperature to the wet bulb temperature) are assumed to be constant at 77oF and 8oF, respectively.

The capital costs of cooling tower systems include the following equipment:

- Cooling tower (crossflow, mechanically-induced) and typical accessories
- Piping and valves (305 meters (1000 ft.) carbon steel)
- Cold water storage tank (1 hour retention time)
- Recirculation pump, centrifugal
- Chemical treatment system (for pH, slime and corrosion control)

For nominal recirculation flow rates greater than 159,100 l/hr (700 gpm), multiple cooling towers are assumed to be required.

A holding tank system would consist of a holding tank and a recirculation pump.

The direct capital costs include purchased equipment cost, installation and delivery. Installation costs for cooling towers were assumed to be 200 percent of the cooling tower cost based on information supplied by vendors.

Direct annual costs included raw chemicals for water treatment, fan energy requirements, and maintenance and operating labor was assumed to be constant at 60 hours per year. The water treatment chemical cost was based on a rate of $5/gpm of recirculated water.

Capital and annual costs for cooling towers and holding tanks are presented in Figure VIII-28.

Countercurrent Cascade Rinsing. This technology is used to reduce water use in rinsing operations for BAT options. It involves multiple-stage rinsing, with product and rinse water moving in opposite directions (see Section VII for more details on theory). This allows for a significant reduction in flow over single stage rinsing, while achieving the same product cleanliness by contacting the most contaminated rinse water with the incoming product.

The costs for countercurrent cascade rinsing apply to a two-stage rinse system, each consisting of the following equipment:

- Two fiberglass rectangular tanks (Existing source costs include only one tank since the other tank was assumed to be already in place).
- One centrifugal, transfer pump,
- One sparger (air diffuser) for agitation,
- One blower (including motor) for supplying air to the sparger.

Tanks were sized based on the production rate associated with each rinsing operation, as follows:

Production Rate (kkg/yr)	Tank Volume (gallons)
1,000	1,500
1,000 - 5,000	3,600
5,000	8,000

The above tank volumes and breakpoints were based on information obtained from dcp's and a telephone survey of several anodizing plants.

For the case of multiple rinsing operations undergoing countercurrent rinsing, each operation was costed individually because of the wide variability in the rinsing flowrates due to the varying production rates (since reduced flowrates are determined by multiplying the flow allowance by the production).

When it was determined from a plant's dcp that two-stage countercurrent cascade rinsing could be achieved by converting two existing adjacent rinse tanks, only piping and pump costs were accounted for. A constant value of $1,000 was estimated for the piping costs.

Capital and annual costs for countercurrent cascade rinsing are presented in Figure VIII-29.

Contract Hauling. Concentrated sludge and waste oils are removed on a contract basis for off-site disposal. The cost of contract hauling depends on the classification of the waste as being either hazardous or nonhazardous. For nonhazardous wastes, a rate of $0.106/liter ($0.40/gallon) was used in determining contract hauling costs. This value is based on reviewing information from several sources, including a paint industry survey, comments from the aluminum forming industry, and the literature. The contract hauling cost for nonhazardous waste was used in this cost estimation because the Agency believes that the wastes generated from aluminum forming plants are not hazardous as defined under 40 CFR 261. The capital cost associated with contract hauling is assumed to be zero. The annual cost of contract hauling is presented in Figure VIII-30.

Regeneration. As discussed in Section X, the regeneration technology applicable to cleaning or etching baths is no longer included in the Option 2 and Option 3 model treatment technologies. For the plants costed after proposal, the flows attributable to cleaning or etching baths were added to the total flow treated through the appropriate end-of-pipe treatment technologies.

SUMMARY OF COSTS

A summary of the capital and annual costs associated with compliance with the aluminum forming regulation is presented in Table VIII-11 for each subcategory.

NORMAL PLANT

In order to estimate costs, pollutant removals, and nonwater quality aspects for new sources, the Agency developed a normal plant for each of the six subcategories. A normal plant is a theoretical plant which has each of the manufacturing operations covered by the subcategory and production that is the average level of each operation in that subcategory. (The total production for the core operation and for each ancillary operation in the subcategory was divided by the number of plants in the subcategory.) The normal plant flows are the characteristic production times the production normalized flow allowance at each option. In addition, a normal plant was assumed to operate 8 hours per day, 5 days per week, 50 weeks per year. Tables VIII-12 to VIII-17 present the composition of the normal plants for each subcategory. The capital and annual costs generated for each normal plant for the three options are presented in Table VIII-18.

NONWATER QUALITY ASPECTS

The elimination or reduction of one form of pollution may aggravate other environmental problems. Therefore, Sections 304(b) and 306 of the Act require EPA to consider the nonwater quality environmental impacts (including energy requirements) of certain regulations. In compliance with these provisions, EPA has considered the effect of this regulation on air pollution, solid waste generation, water scarcity, and energy consumption. This regulation was circulated to and reviewed by EPA personnel responsible for nonwater quality environmental programs. While it is difficult to balance pollution problems against each other and against energy utilization, the Administrator has determined that the impacts identified below are justified by the benefits associated with compliance with the limitations and standards. The following are the nonwater quality environmental impacts (including energy requirements) associated with compliance with the aluminum forming regulation.

Air Pollution

Imposition of BPT, BAT, NSPS, PSES, and PSNS will not create any substantial air pollution problems because the wastewater treatment technologies required to meet these limitations and standards do not cause air pollution.

Solid Waste

EPA estimates that aluminum forming facilities generated 79,000 kkg (87,000 tons) of solid wastes (wet basis) in 1977 due to the treatment of wastewater. These wastes were comprised of treatment system sludges containing toxic metals, including chromium, zinc, and cyanide; aluminum; and oil removed during oil skimming and chemical emulsion breaking that contains toxic organics.

EPA estimates that BPT will contribute an additional 52 kkg (57 tons) per year of solid wastes over that which is currently being generated by the aluminum forming industry. BAT and PSES will increase these wastes by approximately 77 kkg (85 tons) per year beyond BPT levels. These sludges will necessarily contain additional quantities (and concentrations) of toxic metal pollutants. The normal plant was used to estimate the sludge generated at NSPS and PSNS and is estimated to be a 3 percent increase over BAT and PSES.

The Agency considered the solid wastes that would be generated at aluminum forming plants by lime and settle treatment technologies and believes that they are not hazardous under Section 3001 of the Resource Conservation and Recovery Act (RCRA). This judgment is made based on the recommended technology of lime precipitation. By the addition of a small excess of lime during treatment, similar sludges, specifically toxic metal bearing sludges generated by other industries such as the iron and steel industry, passed the EP toxicity test. See 40 CFR 261.24 (45 FR 33084 (May 19, 1980)).

The Agency requested specific data and information in response to comments from three companies that claimed that aluminum forming lime and settle treatment sludges should be classified as hazardous. The responses did not support their comments that solid wastes generated by treatment of aluminum forming wastewater would be classified as hazardous under RCRA. The Agency believes that the proper treatment of this wastewater through the recommended lime and settle treatment technology would create a non-hazardous sludge. Since these aluminum forming solid wastes are not believed to be hazardous, no estimates were made of costs for disposing of them as hazardous wastes in accordance with RCRA requirements.

Wastes which are not hazardous must be disposed of in a manner that will not violate the open dumping prohibition of Section 4005 of RCRA. The Agency has calculated as part of the costs for wastewater treatment the cost of hauling and disposing of additional wastes generated as a result of these requirements.

Only wastewater treatment sludge generated by cyanide treatment is likely to be hazardous under the regulations implementing subtitle C of RCRA. Wastewater sludge generated by cyanide treatment of aluminum forming solution heat treatment contact cooling water may contain cyanides and may exhibit extraction procedure (EP) toxicity. Therefore, these wastes may require disposal as a hazardous waste. Wastewater treatment sludge from cyanide treatment of a process waste stream is generated separately from lime and settle sludge and may be disposed of separately. Disposal costs for these hazardous wastes were based on $0.80 per gallon ($0.21 per liter). The disposal cost is based on information obtained from a number of sources including a study of battery manufacturing plants in 1981, comments received on the proposed battery manufacturing regulation, and a study performed by Charles River Associates, Inc., and the costs have been updated to 1982 dollars. We estimate that five plants in the category may need to have cyanide precipitation, generating an estimated 3,200 kkg of potentially hazardous sludge. The additional total annual disposal cost for this sludge is $283,200.

Generators of these wastes must test the waste to determine if the wastes meet any of the characteristics of hazardous waste. See 40 CFR 262.11 (45 FR 12732-12733 (February 26, 1980)). The Agency may also list these sludges as hazardous pursuant to 40 CFR 260.11 (45 FR 33121 (May 19, 1980)), as amended at 45 FR 76624 (November 19, 1980)).

If these wastes are identified as hazardous, they will come within the scope of RCRA's "cradle-to-grave" hazardous waste management program, requiring regulation from the point of generation to point of final disposition. EPA's generator standards would require generators of hazardous aluminum forming wastes to meet containerization, labeling, recordkeeping, and reporting requirements. In addition, if aluminum formers dispose of hazardous wastes off-site, they would have to prepare a manifest which would track the movement of the wastes from the generator's premises to a permitted off-site treatment, storage, or disposal facility. See 40 CFR 262.20 (45 FR 33142 (May 19, 1980)). The transporter regulations require transporters of hazardous wastes to comply with the manifest system to assure that the wastes are delivered to a permitted facility. See 40 CFR 263.20 (45 FR 33151 (May 19, 1980)), as amended at 45 FR 86973 (December 31, 1980)). Finally, RCRA regulations establish standards for hazardous waste treatment, storage, and disposal facilities allowed to receive such wastes. See 40 CFR Parts 264 and 265.

Consumptive Water Loss

Treatment and control technologies that require extensive recycling and reuse of water may require cooling mechanisms. Evaporative cooling mechanisms can cause water loss and contribute to water scarcity problems--a primary concern in arid and semi-arid regions. While this regulation assumes water reuse, the overall amount of reuse through evaporative cooling mechanisms is low and the quantity of water involved is not significant. In addition, most aluminum forming plants are located east of the Mississippi where water scarcity is not a problem. We conclude that the consumptive water loss is insignificant and that the pollution reduction benefits of recycle technologies outweigh their impact on consumptive water loss.

Energy Requirements

EPA estimates that the achievement of BPT effluent limitations will result in a net increase in electrial energy consumption of approximately 65 million kilowatt-hours per year. The BAT effluent technology should not substantially increase the energy requirements of BPT because reducing the flow reduces the pumping requirements, the agitation requirement for mixing wastewater, and other volume-related energy requirements. Therefore, the BAT limitations are assumed to require an equivalent energy consumption to that of the BPT limitations. To achieve the BPT and BAT effluent limitations, a typical direct discharger will increase total energy consumption by less than 1 percent of the energy consumed for production purposes.

The Agency estimates that PSES will result in a net increase in electrical energy consumption of approximately 50 million kilowatt-hours per year. To achieve PSES, a typical existing indirect discharger will increase energy consumption by less than 1 percent of the total energy consumed for production purposes.

NSPS will not significantly add to total energy consumption of the energy. A normal plant for each subcategory was used to estimate the energy requirements for new sources. A new source wastewater treatment system will add approximately 1 million kilowatt-hours per year to the total industry energy requirements. PSNS, like NSPS, will not significantly add to total energy consumption.

Table VIII-1

MAJOR DIFFERENCES BETWEEN COST METHODOLOGIES

Module/Factor	Contractor A	Contractor B
System Capital Cost Factor	1.35 x Total Direct Capital Cost	1.375 x Total Direct Capital Cost
Influent Concentration	Constant concentration assumption, pollutants not tracked, sludge production rates (g/1,000 gal)	Constant mass assumption, pertinent pollutants tracked, sludge rates higher (usually) especially for reduced flows
Enclosures	Enclosures costed for most equipment	Enclosures only costed for excess area exceeded
Contract Hauling Cost Rate	Assumed $.30/gal in 1978 Assumed 24 hrs/day x 365 days/yr hauled	Assumed $.40/gal in March 1982 Operating days per year retained as variable (usually 4,000 or 6,000 hrs/year)
Chemical Precipitation	Includes sulfuric acid feed system, separate flocculator and enclosure. Including these equipment increases costs significantly.	Does not include equipment described under Contractor A column
Vacuum Filter	Costs include holding tank for sludge and clarifier underflow	Does not include holding tanks
Cyanide Treatment	Costs include cyanide treatment for all wastewater sources from operations which were found to contain cyanide	Cost of cyanide treatment is not included because plants are expected to choose substitution instead of the more costly removal technology

Table VIII-2

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES - PRE-PROPOSAL

Unit Process	Equation	Applicability
Skimming (Gravity oil-in-water separation)	$C - \text{antilog}\ [0.0415\ (\log x)^3 - 0.00829\ (\log x)^2 + 0.051\ (\log x) + 4.16]$	$1 < x < 1,000$
	$A - \text{antilog}\ [0.00478\ (\log x)^3 + 0.0766\ (\log x)^2 + 0.0125\ (\log x) + 3.52]$	$1 < x < 1,000$
Dissolved air flotation	$C = \text{antilog}\ [0.0369\ (\log x)^3 - 0.0461\ (\log x)^2 - 0.00537\ (\log x) + 4.77] + 1,620$	$7 < x < 40$
	$C = \text{antilog}\ [0.0369\ (\log x)^3 - 0.0461\ (\log x)^2 - 0.00537\ (\log x) + 4.77] + 40.5x$	$40 < x < 1,000$
	$A = \text{antilog}\ [0.0711\ (\log x)^3 - 0.329\ (\log x)^2 + 0.551\ (\log x) + 4.05]$	$7 < x < 1,000$
Thermal emulsion breaking	$C = \text{antilog}\ [-0.0313\ (\log x)^3 + 0.1900\ (\log x)^2 + 0.8264\ (\log x) + 5.159]$	$0.1 < x < 8$
	$A = \text{antilog}\ [-0.0351\ (\log x)^3 + 0.1438\ (\log x)^2 + 0.6535\ (\log x) + 4.697] - 72\ x\ (\text{days/wk})\ (\text{wk/yr})$	$0.1 < x < 8$
Caustic pH adjustment	$C = 33,900\ x^{0.245} + 3,600$	$7 < x < 20$
	$C = 33,900\ x^{0.245} + 527\ x^{0.662}$	$20 < x < 1,000$
	$A = \text{antilog}\ [0.0755\ (\log x)^3 - 0.375\ (\log x)^2 + 1.20\ (\log x) + 3.24]$	$7 < x < 1,000$
Acid pH adjustment	$C = \text{antilog}\ [0.034\ (\log x)^3 - 0.167\ (\log x)^2 + 0.461\ (\log x) + 4.07] + 3,645$	$5 < x < 20$
	$C = \text{antilog}\ [0.034\ (\log x)^3 - 0.167\ (\log x)^2 + 0.461\ (\log x) + 4.07] + 526.5\ x^{0.662}$	$20 < x < 1,000$
	$A = \text{antilog}\ [-0.0345\ (\log x)^3 + 0.167\ (\log x)^2 + 0.194\ (\log x) + 3.65]$	$5 < x < 1,000$

Table VIII-2 (Continued)

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES - PRE-PROPOSAL

Unit Process	Equation	Applicability
Chemical emulsion breaking	$C = \text{antilog}\,[0.0373\,(\log x)^3 - 0.181\,(\log x)^2 + 0.323\,(\log x) + 4.60] + \text{antilog}\,[-0.00854\,(\log x)^3 + 0.125\,(\log x)^2 + 0.0403\,(\log x) + 3.62]$	$7 < x < 1{,}000$
	$A = \text{antilog}\,[0.0272\,(\log x)^3 + 0.0321\,(\log x)^2 + 0.180\,(\log x) + 4.04]$	$7 < x < 1{,}000$
Multimedia filtration	$C = 6{,}800\,x^{0.598} + 1{,}620$	$1 < x < 12$
	$C = 6{,}800\,x^{0.598} + 182\,x^{0.89}$	$12 < x < 1{,}000$
	$A = \text{antilog}\,[-0.0157\,(\log x)^3 + 0.183\,(\log x)^2 - 0.0297\,(\log x) + 3.38]$	$1 < x < 1{,}000$
Lime and settle [L&S] 200 mg/l lime dosage	$C = \text{antilog}\,[0.0033\,(\log x)^3 + 0.0365\,(\log x)^2 + 0.256\,(\log x) + 4.45] + 7{,}290$	$1 < x < 20$
	$C = \text{antilog}\,[0.0033\,(\log x)^3 + 0.0365\,(\log x)^2 + 0.256\,(\log x) + 4.45] + 1{,}012.5\,x^{0.662}$	$20 < x < 1{,}000$
	$A = \text{antilog}\,[0.00402\,(\log x)^3 + 0.0114\,(\log x)^2 + 0.275\,(\log x) + 4.06]$	$1 < x < 1{,}000$
2,000 mg/l lime dosage	$C = \text{antilog}\,[-0.00236\,(\log x)^3 + 0.0645\,(\log x)^2 + 0.281\,(\log x) + 4.49] + 7{,}290$	$1 < x < 20$
	$C = \text{antilog}\,[-0.00236\,(\log x)^3 + 0.0645\,(\log x)^2 + 0.281\,(\log x) + 4.49] + 1{,}012.5\,x^{0.662}$	$20 < x < 1{,}000$
	$A = \text{antilog}\,[0.00720\,(\log x)^3 + 0.0450\,(\log x)^2 + 0.249\,(\log x) + 4.08]$	$1 < x < 1{,}000$
Hexavalent chromium reduction	$C = \text{antilog}\,[-0.0248\,(\log x)^3 + 0.108\,(\log x)^2 + 0.213\,(\log x) + 4.10] + 2{,}835$	$0.2 < x < 20$
	$C = \text{antilog}\,[-0.0248\,(\log x)^3 + 0.108\,(\log x)^2 + 0.213\,(\log x) + 4.10] + 384.8\,x^{0.670}$	$20 < x < 1{,}000$
	$A = \text{antilog}\,[0.132\,(\log x)^3 - 0.447\,(\log x)^2 + 0.795\,(\log x) + 2.95]$	$1 < x < 1{,}000$

Table VIII-2 (Continued)

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES - PRE-PROPOSAL

Unit Process	Equation	Applicability
Chemical emulsion breaking	$C = \text{antilog}\ [0.0373\ (\log x)^3 - 0.181\ (\log x)^2 + 0.323\ (\log x) + 4.60] + \text{antilog}\ [-0.00854\ (\log x)^3 + 0.125\ (\log x)^2 + 0.0403\ (\log x) + 3.62]$	$7 < x < 1{,}000$
	$A = \text{antilog}\ [0.0272\ (\log x)^3 + 0.0321\ (\log x)^2 + 0.180\ (\log x) + 4.04]$	$7 < x < 1{,}000$
Multimedia filtration	$C = 6{,}800\ x^{0.598} + 1{,}620$	$1 < x < 12$
	$C = 6{,}800\ x^{0.598} + 182\ x^{0.89}$	$12 < x < 1{,}000$
	$A = \text{antilog}\ [-0.0157\ (\log x)^3 + 0.183\ (\log x)^2 - 0.0297\ (\log x) + 3.38]$	$1 < x < 1{,}000$
Lime and settle [L&S] 200 mg/l lime dosage	$C = \text{antilog}\ [0.0033\ (\log x)^3 + 0.0365\ (\log x)^2 + 0.256\ (\log x) + 4.45] + 7{,}290$	$1 < x < 20$
	$C = \text{antilog}\ [0.0033\ (\log x)^3 + 0.0365\ (\log x)^2 + 0.256\ (\log x) + 4.45] + 1{,}012.5\ x^{0.662}$	$20 < x < 1{,}000$
	$A = \text{antilog}\ [0.00402\ (\log x)^3 + 0.0114\ (\log x)^2 + 0.275\ (\log x) + 4.06]$	$1 < x < 1{,}000$
2,000 mg/l lime dosage	$C = \text{antilog}\ [-0.00236\ (\log x)^3 + 0.0645\ (\log x)^2 + 0.281\ (\log x) + 4.49] + 7{,}290$	$1 < x < 20$
	$C = \text{antilog}\ [-0.00236\ (\log x)^3 + 0.0645\ (\log x)^2 + 0.281\ (\log x) + 4.49] + 1{,}012.5\ x^{0.662}$	$20 < x < 1{,}000$
	$A = \text{antilog}\ [0.00720\ (\log x)^3 + 0.0450\ (\log x)^2 + 0.249\ (\log x) + 4.08]$	$1 < x < 1{,}000$
Hexavalent chromium reduction	$C = \text{antilog}\ [-0.0248\ (\log x)^3 + 0.108\ (\log x)^2 + 0.213\ (\log x) + 4.10] + 2{,}835$	$0.2 < x < 20$
	$C = \text{antilog}\ [-0.0248\ (\log x)^3 + 0.108\ (\log x)^2 + 0.213\ (\log x) + 4.10] + 384.8\ x^{0.670}$	$20 < x < 1{,}000$
	$A = \text{antilog}\ [0.132\ (\log x)^3 - 0.447\ (\log x)^2 + 0.795\ (\log x) + 2.95]$	$1 < x < 1{,}000$

Table VIII-2 (Continued)

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES - PRE-PROPOSAL

Unit Process	Equation	Applicability
Activated carbon adsorption		
GAC contacting	$C = \text{antilog}\ [-0.0255\ (\log x)^3 + 0.211\ (\log x)^2 - 0.00279\ (\log x) + 4.65] + 2{,}633$	$4 < x < 10$
	$C = \text{antilog}\ [-0.0255\ (\log x)^3 + 0.211\ (\log x)^2 - 0.00279\ (\log x) + 4.65] + 405\ x^{0.808}$	$10 < x < 1{,}000$
	$A = 7{,}000$	$4 < x < 70$
	$A = \text{antilog}\ [-0.00286\ (\log x)^3 + 0.0996\ (\log x)^2 + 0.0834\ (\log x) + 3.37]$	$70 < x < 1{,}000$
GAC replacement throwaway system	$A = 580\ p$	$0.2 < p < 400$
GAC thermal regeneration	$C = \text{antilog}\ [-3.383\ (\log p)^3 + 26.93\ (\log p)^2 - 70.38\ (\log p) + 66.28] + 203.9\ p^{0.567}$	$400 < p < 1{,}000$
	$C = \text{antilog}\ [0.0564\ (\log p)^3 - 0.446\ (\log p)^2 + 1.40\ (\log p) + 4.41] + 203.9\ p^{0.567}$	$1{,}000 < p < 2{,}000$
	$A = 8{,}450\ p^{0.48} + 42.4\ p$	$400 < p < 2{,}000$
Vacuum filtration	$C = \text{antilog}\ [-0.05707\ (\log v)^3 + 0.595\ (\log v)^2 - 1.15\ (\log v) + 5.57] + 4{,}455$	$10 < v < 90$
	$C = \text{antilog}\ [-0.05707\ (\log v)^3 + 0.595\ (\log v)^2 - 1.15\ (\log v) + 5.57] + 141.8\ v^{0.76}$	$90 < v < 1{,}000$
	$A = \text{antilog}\ [0.0203\ (\log v)^3 - 0.0736\ (\log v)^2 + 0.215\ (\log v) + 4.25]$	$10 < v < 1{,}000$

Table VIII-2 (Continued)

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES - PRE-PROPOSAL

Unit Process	Equation	Applicability
Recycle	$C = \text{antilog}\,[0.00780\,(\log x)^3 + 0.00444\,(\log x)^2 + 0.0425\,(\log x) + 4.96] + 1{,}013$	$10 < x < 200$
	$C = \text{antilog}\,[0.00780\,(\log x)^3 + 0.00444\,(\log x)^2 + 0.0425\,(\log x) + 4.96] + 56.7\,x^{0.561}$	$200 < x < 1{,}000$
	$C = \text{antilog}\,[-0.118\,(\log x)^3 + 1.58\,(\log x)^2 - 6.04\,(\log x) + 12.43] + 56.7\,x^{0.561}$	$1{,}000 < x < 5{,}000$
	$A = \text{antilog}\,[0.0443\,(\log x)^3 - 0.203\,(\log x)^2 + 0.477\,(\log x) + 3.73]$	$10 < x < 1{,}000$
	$A = \text{antilog}\,[-0.122\,(\log x)^3 + 1.58\,(\log x)^2 - 5.83\,(\log x) + 11.1]$	$1{,}000 < x < 5{,}000$
Holding tank	$C = \text{antilog}\,[0.135\,(\log g)^3 - 1.12\,(\log g)^2 + 3.67\,(\log g) - 1.21] + 25.7\,g^{0.654}$	$150 < g < 20{,}000$
	$C = \text{antilog}\,[0.150\,(\log g)^3 - 2.32\,(\log g)^2 + 12.44\,(\log g) - 17.97] + 25.7\,g^{0.654}$	$20{,}000 < g < 1{,}000{,}000$
Pumping	$C = \text{antilog}\,[-0.0135\,(\log x)^3 + 0.119\,(\log x)^2 + 0.0654\,(\log x) + 3.86] + 1{,}013$	$1 < x < 200$
	$C = \text{antilog}\,[-0.0135\,(\log x)^3 + 0.119\,(\log x)^2 + 0.0654\,(\log x) + 3.86] + 56.7\,x^{0.561}$	$200 < x < 1{,}000$
	$C = \text{antilog}\,[-0.0111\,(\log x)^3 + 0.280\,(\log x)^2 - 0.977\,(\log x) + 5.47] + 56.7\,x^{0.561}$	$1{,}000 < x < 5{,}000$
	$A = \text{antilog}\,[0.00589\,(\log x)^3 + 0.00446\,(\log x)^2 + 0.0528\,(\log x) + 3.94]$	$1 < x < 1{,}000$
	$A = \text{antilog}\,[0.0347\,(\log x)^3 - 0.185\,(\log x)^2 + 0.489\,(\log x) + 3.56]$	$1{,}000 < x < 5{,}000$
Equalization	$C = 8{,}000\,x^{0.483}$	$1 < x < 1{,}000$
	$A = \text{antilog}\,[-0.0118\,(\log x)^3 + 0.15\,(\log x)^2 + 0.00665\,(\log x) + 3.34]$	$1 < x < 1{,}000$

Table VIII-2 (Continued)

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES - PRE-PROPOSAL

Unit Process	Equation	Applicability
Cyanide oxidation	$C = \text{antilog}\ [0.00323\ (\log x)^3 + 0.0220\ (\log x)^2 + 0.0672\ (\log x) + 4.61]$	$0.1 < x < 10$
	$C = \text{antilog}\ [-0.131\ (\log x)^3 + 0.964\ (\log x)^2 - 1.69\ (\log x) + 5.60]$	$10 < x < 300$
	$A = \text{antilog}\ [0.0145\ (\log x)^3 + 0.0805\ (\log x)^2 + 0.0363\ (\log x) + 3.54]$	$15 < x < 200$
Contractor hauling	$A = 109\ s$	
Monitoring	$C = 8{,}000$	$1 < x < 2{,}000$
	$A = 5{,}000$	$1 < x < 2{,}000$

C = total capital cost (dollars)
A = annual cost, not including amortization and depreciation (dollars/year)
x = wastewater flow (gallons/minute)
s = sludge production rate (gallons/day)
p = carbon exhaustion rate (1,000 pounds/year)
v = vacuum filter area (sq. ft.)
g = holding tank capacity (gallons)

Table VIII-3

OILY SLUDGE PRODUCTION ASSOCIATED WITH ALUMINUM FORMING

Operation	Oily Sludge Production (gal/1,000 gal)
Direct chill casting	0.2
Continuous casting	0.2
Extrusion	
- contact cooling	0.07
- heat treatment contact cooling	0.08
- dummy block contact cooling	0.14
- die cleaning	--
Hot rolling oil	Site-specific
Etch line	
- acid rinse	--
- deoxidant dip	--
- deoxidant rinse	--
- caustic rinse	--
- water rinse	--
- leveler rinse	--
- scrubber	--
- detergent rinse	--
Forging heat treatment contact cooling	0.07
Forging scrubber	0.32
Drawing oil	Site-specific
Drawing heat treatment contact cooling	
Cold rolling oil	Site-specific
Cold rolling heat treatment contact cooling	--
Foil rolling oil	Site-specific

Table VIII-4

LIME DOSAGE REQUIREMENTS AND LIME SLUDGE PRODUCTION ASSOCIATED WITH ALUMINUM FORMING

Operation	Lime Dosage (mg/l)	Lime Sludge Production (gal/1,000 gal)
Direct chill casting	--	--
Continuous casting	--	--
Extrusion		
- contact cooling	--	--
- heat treatment contact cooling	--	--
- dummy block contact cooling	--	--
- die cleaning	2,000	46
Hot rolling oil	2,000	38
Etch line		
- acid rinse	2,000	63
- deoxidant dip	2,000	63
- deoxidant rinse	2,000	63
- caustic rinse	2,000	63
- water rinse	2,000	63
- leveler rinse	2,000	63
- scrubber	2,000	63
- detergent rinse	2,000	63
Forging heat treatment contact cooling	200	6
Forging scrubber	200	6
Drawing oil	2,000	38
Drawing heat treatment contact cooling	--	--
Cold rolling oil	2,000	38
Cold rolling heat treatment contact cooling	--	--
Foil rolling oil	2,000	38

Table VIII-5

CARBON EXHAUSTION RATES ASSOCIATED WITH ALUMINUM FORMING

Operation	Carbon Exhaustion Rate (lbs carbon/ 1,000 gal)
Direct chill casting	2
Continuous casting	2
Extrusion	
- contact cooling	2
- heat treatment contact cooling	
- dummy block contact cooling	0.5
- die cleaning	--
Hot rolling oil	10
Etch line	
- acid rinse	0.5
- deoxidant dip	0.5
- deoxidant rinse	0.5
- caustic rinse	2
- water rinse	1
- leveler rinse	1
- scrubber	1
- detergent rinse	1
Forging heat treatment contact cooling	--
Forging scrubber	5
Drawing oil	10
Drawing heat treatment contact cooling	0.5
Cold rolling oil	10
Cold rolling heat treatment contact cooling	0.3
Foil rolling oil	10

Table VIII-6

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES - POST-PROPOSAL

Equipment	Equation	Range of Validity
Agitators, C-clamp	$C = 839.1 + 587.5\ (HP)$ $A = 2739.89 + 403.365\ (HP) + 0.7445\ (HP)^2$	$0.25 < HP < 0.33$
Agitators, Top Entry	$C = 1585.55 + 125.302\ (HP) - 3.27437\ (HP)^2$ $A = 2739.89 + 403.365\ (HP) + 0.7445\ (HP)^2$	$0.33 < HP < 5.0$
Clarifier, Concrete	$C = 78400 + 32.65\ (S) - 7.5357 \times 10^{-4}\ (S)^2$ $A = \exp[9.40025 - 0.539825\ (\ln S) + 0.551186\ (\ln S)^2]$	$500 < S < 12,000$
Clarifier, Steel	$C = 41197.1 + 72.0979(S) + 0.0106542(S)^2$ $A = \exp[9.40025 - 0.539825\ (\ln S) + 0.0551186\ (\ln S)^2]$	$50 < S < 2800$
Contract Hauling	$C = 0$ $A = 0.40\ (G)(HPY)$	Non Hazardous
Cooling Tower System	$C = \exp[8.76408 + 0.07048\ (\ln T) + 0.050949\ (\ln T)^2]$ $A = \exp[9.08702 - 0.75544\ (\ln T) + 0.140379\ (\ln T)^2]$	$1 < T < 700$
Feed System Alum	$C = \exp[16.2911 - 0.206595\ (\ln F) + 0.06448\ (\ln F)^2]$ $A = [0.52661 + 0.11913\ (F) + 1.964 \times 10^{-8} (F)^2]\ HPY$	$10 < F < 1000$

Table VIII-6 (Continued)

COST EQUATIONS FOR RECOMMENDED TREATMENT
AND CONTROL TECHNOLOGIES - POST-PROPOSAL

Equipment	Equation	Range of Validity
Equalization Tanks, Steel	$C = 14,759.8 + 0.170817\ (V) - 8.44271 \times 10^{-8}\ (V)^2$	$24,000 < V < 500,000$
	$C = 3,100.44 + 1.19041\ (V) - 1.7288 \times 10^{-5}\ (V)^2$	$1,000 < V < 24,000$
	$C = \exp[6.88763 - 0.643189\ (\ln V) + 0.11525\ (\ln V)^2]$	$V < 1,000$
	$A = 0.05\ (C)$	
Feed System, Batch Lime	$C = 1697.79 + 19.489\ (B) - 0.036824\ (B)^2$ $C = 16149.2 + 10.2512\ (B) - 1.65864 \times 10^{-3}(B)^2$	$5 < B < 1000$
	$A = \exp[2.91006 - 0.44837\ (\ln B) + 0.0840605\ (\ln B)^2] BPY + 1090$	
Feed System, Lime	$C = \exp[8.64445 + 0.790902\ (\ln F) - 0.04556\ (\ln F)^2]$	$10 < F < 10,000$
	$A = \exp[-1.90739 + 0.60058\ (\ln F) + 0.017236\ (\ln F)^2](HPY)$	
Feed System, Polymer	$C = 24190 + 1024.38\ (F) + 46.3977\ (F)^2$ $A = [0.479342 + 2.25578\ (F) + 8.49822 \times 10^{-4}(F)^2](HPY)$	$0.04 < F < 10$
Feed System, Sulfuric Acid	$C = 10858.2 + 33.3414\ (F) - 3.3325 \times 10^{-3}(F)^2$	$6 < F < 3200$
	$A = \exp[-2.31035 + 0.707633\ (\ln F) + 0.0215896\ (\ln F)^2](HPY)$	
Multimedia Filter	$C = 10.888 + 277.85\ (SA) - 0.154337\ (SA)^2$ $A = \exp[8.20771 + 0.275272\ (\ln SA) + 0.0323124\ (\ln SA)^2]$	$7 < SA < 500$

Table VIII-6 (Continued)

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES - POST-PROPOSAL

Equipment	Equation	Range of Validity
Oil/Water Separator	$C = 5,542.07 + 65.7158\ (Y) - 0.029627\ (Y)^2$ $A = 783.04 + 6.3616\ (X) - 0.001736\ (X)^2$	$0 < Y < 700$
Pumps, Centrifugal	$C = \exp[6.31076 + 0.228887(\ln Y) + 0.0206172\ (\ln Y)^2]$ $A = \exp[6.67588 + 0.01335\ (\ln Y) + 0.062016\ (\ln Y)^2$	$3 < Y < 3500$
Pumps, Sludge	$C = 2264.31 + 21.0097\ (Y) - 0.0037265\ (Y)^2$ $A = \exp[7.64414 + 0.192172\ (\ln Y) + 0.0202428\ (\ln Y)^2]$	$5 < Y < 500$
Spray Rinsing System	$C = 3212.72 - 0.009005\ (X) + 1.004 \times 10^{-6}\ (X)^2$ $A = N[1.05(HPY) + 64.246 - 1.801 \times 10^{-4}(X) + 2.008 \times 10^{-8}(X)^2]$	
Sulfonator	$C = 14336.3 + 38.1582\ (F) - 0.156326\ (F)^2$ $A = 6934.09 + 2704.2\ (F) - 1.08636\ (F)^2$	$4.0 < F < 350$
Tank, Batch Reactor	$C = 3100.44 + 1.19041\ (V) - 1.7288 \times 10^{-5}(V)^2$ $A = \exp[8.65018 - 0.0558684\ (\ln X) + 0.0145276\ (\ln X)^2]$	$500 < V < 24,000$ $100 < X < 100,000$
Tank, Concrete	$C = 5800 + 0.8V$ $A = 0$	$6000 < V < 24,000$
Tank, Fiberglass	$C = 3100.44 + 1.19041\ (V) - 1.7288 \times 10^{-5}(V)^2$ $A = 0$	$500 < V < 24,000$

Table VIII-6 (Continued)

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES (POST-PROPOSAL)

Equipment	Equation	Range of Validity
Tank, Large Steel	$C = 3128.83 + 2.37281\ (V) - 7.10689 \times 10^{-5} (V)^2$ $A = 0$	$500 < V < 12{,}000$
Tank, Small Steel	$C = 692.824 + 6.16706\ (V) - 3.95367 \times 10^{-3} (V)^2$ $A = 0$	$100 < V < 500$
Vacuum Filter	$C = 67595.1 + 504.701\ (SA) - 0.520067\ (SA)^2$ $A = 44096.8 + 138.057\ (SA) - 0.0485584\ (SA)^2$	$9.4 < SA < 750$
Vacuum Filter Housing	$C = 45[308.253 + 0.836592\ (SA)]$ $A = 4.96[308.253 + 0.836592\ (SA)]$	$9.4 < SA < 750$

C = Direct capital, or equipment costs (1982 dollars)
A = Direct annual costs (1982 dollars/year)
B = Batch chemical feed rate (pounds/hour)
BPY = Number of batches per year
F = Chemical feed rate (pounds/hour)
G = Sludge disposal rate (gallons/hour)
HP = Power requirement (horsepower)
HPY = Plant operating hours (hours/year)
S = Clarifier surface area (square feet)
SA = Filter surface area (square feet)
T = Cooling capcity in evaporative tons (°F gallons/minute)
V = Tank capacity (gallons)
X = Wastewater flowrate (liters/hour)
Y = Wastewater flowrate (gallons/minute)

Table VIII-7

COMPONENTS OF TOTAL CAPITAL INVESTMENT - POST-PROPOSAL

Item Number	Item	Cost
1	Bare Module Capital Costs	Direct capital costs from model[a]
2	Electrical & instrumentation	0% of item 1
3	Yard piping	0% of item 2
4	Enclosure	Included in item 1
5	Pumping	Included in item 1
6	Retrofit allowance	Included in item 1
7	Total Module Cost	Item 1 + items 2 through 6
8	Engineering/admin. & legal	10.0% of item 7
9	Construction/yardwork	0% of item 7
10	Monitoring	0% of item 7
11	Total Plant Cost	Item 7 + items 8 through 10
12	Contingency	15% of item 11
13	Contractor's fee	10% of item 11
14	Total Construction Cost	Item 11 + items 12 through 13
15	Interest during construction	0% of item 14
16	Total Depreciable Investment	Item 14 + item 15
17	Land	0% of item 16
18	Working capital	0% of item 16
19	Total Capital Investment	Item 16 + items 17 through 18

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[a] Direct capital costs include costs of equipment and required accessories, installation, and delivery.

Table VIII-8

COMPONENTS OF TOTAL ANNUALIZED COSTS - POST-PROPOSAL

Item Number	Item	Cost
20	Bare Module Annual Costs	Direct annual costs from model[a]
21	Overhead	0% of item 16[b]
22	Monitoring	See footnote c
23	Insurance	1% of item 16
24	Amortization	CRF x item 16[d]
25	Total Annualized Costs	Item 20 + items 21 through 24

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[a] Direct annual costs include costs of raw materials, energy, operating labor, maintenance and repair.

[b] Item 16 is the total depreciable investment obtained from Table 1.

[c] See page ___ for an explanation of the determination of monitoring costs.

[d] The capital recovery factor (CRF) was used to account for depreciation and the cost of financing.

Table VIII-9

WASTEWATER SAMPLING FREQUENCY - POST-PROPOSAL

Wastewater Discharge (Liters Per Day)	Sampling Frequency
0 - 37,850	Once per month
37,851 - 189,250	Twice per month
189,251 - 378,500	Once per week
378,501 - 946,250	Twice per week
946,250+	Three times per week

Table VIII-10

COST PROGRAM POLLUTANT PARAMETERS

Parameter	Units
Flowrate	liters/hour
pH	pH units
Temperature	°F
Total Suspended Solids	mg/l
Acidity (as $CaCO_3$)	mg/l
Aluminum	mg/l
Ammonia	mg/l
Antimony	mg/l
Arsenic	mg/l
Cadmium	mg/l
Chromium (trivalent)	mg/l
Chromium (hexavalent)	mg/l
Cobalt	mg/l
Copper	mg/l
Cyanide (free)	mg/l
Cyanide (total)	mg/l
Fluoride	mg/l
Iron	mg/l
Lead	mg/l
Manganese	mg/l
Nickel	mg/l
Oil and Grease	mg/l
Phosphorous	mg/l
Selenium	mg/l
Silver	mg/l
Thallium	mg/l
Zinc	mg/l

Table VIII-11

ALUMINUM FORMING CATEGORY COST OF COMPLIANCE ($1982)

Subcategory	BPT		BAT		PSES	
	Capital	Annual	Capital	Annual	Capital	Annual
Rolling With Neat Oils	9,553,000	8,200,300	12,479,200	6,127,500	3,715,900	2,003,700
Rolling With Emulsions	13,957,400	14,476,600	15,118,300	7,972,300	1,421,700	738,500
Extrusion	21,145,000	13,025,772	18,306,031	10,106,251	16,167,813	13,544,148
Forging	--	--	--	--	4,871,590	2,315,186
Drawing With Neat Oils	3,026,700	1,747,300	2,208,200	997,900	1,752,034	961,270
Drawing With Emulsions or Soaps	733,200	474,800	409,000	179,300	209,900	94,709
Industry Totals	48,415,300	37,924,772	48,520,731	25,563,251	28,138,937	19,657,513

Table VIII-12

CHARACTERISTICS OF THE ROLLING WITH NEAT OILS SUBCATEGORY NORMAL PLANT USED FOR COSTING

Operation/Waste Stream	Production (kkg/yr)	Flow (l/yr x 10^6)		
		Option 1	Option 2	Option 3
CORE				
Rolling With Neat Oils Spent Lubricant	166,710	0	0	0
Roll Grinding Spent Emulsion	166,710	0.917	0.917	0.917
Degreasing Solvents	166,710	0	0	0
Sawing Spent Lubricant	166,710	0.801	0.801	0.801
Miscellaneous Waste Streams	166,710	7.502	7.502	7.502
Annealing Scrubber	285	.0075	.0075	.0075
ANCILLARY				
Continuous Sheet Casting	8,152	.015	.015	.015
Solution Heat Treatment	14,694	113.2	29.93	29.93
Cleaning or Etching Bath	1,573	.282	.282	.282
Cleaning or Etching Rinse	1,573	21.88	2.188	2.188
Cleaning or Etching Scrubber Liquor	1,573	25.01	3.041	3.041

Table VIII-13

CHARACTERISTICS OF THE ROLLING WITH EMULSION SUBCATEGORY NORMAL PLANT USED FOR COSTING

Operation/Waste Stream	Production (kkg/yr)	Flow (l/yr x 10^6)		
		Option 1	Option 2	Option 3
CORE				
Rolling With Emulsions Spent Emulsion	150,049	11.18	11.18	11.18
Roll Grinding Spent Emulsion	150,049	0.83	0.83	0.83
Sawing Spent Lubricant	150,049	0.72	0.72	0.72
Miscellaneous Waste Streams	150,049	6.75	6.75	6.75
ANCILLARY				
Direct Chill Casting	131,704	263.3	263.3	263.3
Solution Heat Treatment	8,855	68.23	18.04	18.04
Cleaning or Etching Bath	665	0.12	0.12	0.12
Cleaning or Etching Rinse	665	9.25	0.93	0.93
Cleaning or Etching Scrubber	665	10.57	1.29	1.29

Table VIII-14

CHARACTERISTICS OF THE EXTRUSION SUBCATEGORY NORMAL PLANT USED FOR COSTING

Operation/Waste Stream	Production (kkg/yr)	Flow (l/yr x 10^6)		
		Option 1	Option 2	Option 3
Die Cleaning Bath and Rinse	19,182	0.775	0.284	0.284
Die Cleaning Scrubber	19,182	5.285	5.285	5.285
Degreasing	19,182	0	0	0
Sawing Spent Lubricant	19,182	0.092	0.092	0.092
Miscellaneous Waste Streams	19,182	0.863	0.863	0.863
ANCILLARY				
Extrusion Press Leakage	1,247	1.534	1.534	1.534
Direct Chill Casting	9,794	19.578	19.578	19.578
Solution Heat Treatment	6,186	47.66	12.601	12.601
Cleaning and Etching Bath	504	0.090	0.090	0.090
Cleaning and Etching Rinse	504	7.012	0.701	0.701
Cleaning and Etching Scrubber	504	8.014	0.974	0.974
Degassing Scrubber	442	0.013	0	0

Table VIII-15

CHARACTERISTICS OF THE FORGING SUBCATEGORY NORMAL PLANT USED FOR COSTING

Operation/Waste Stream	Production (kkg/yr)	Flow (l/yr x 10^6)		
		Option 1	Option 2	Option 3
CORE				
Forging	4,793	0	0	0
Degreasing Spent Solvent	4,793	0	0	0
Sawing Spent Lubricant	4,793	0.023	0.023	0.023
Miscellaneous Waste Streams	4,793	0.216	0.216	0.216
ANCILLARY				
Forging Scrubber Liquor	3,638	5.63	0.343	0.343
Solution Heat Treatment	4,126	31.79	8.405	8.405
Cleaning or Etching Bath	4,734	0.847	0.847	0.847
Cleaning or Etching Rinse	4,734	65.859	6.586	6.586
Cleaning or Etching Scrubber	4,734	75.271	9.151	9.151

Table VIII-16

CHARACTERISTICS OF THE DRAWING WITH NEAT OILS SUBCATEGORY NORMAL PLANT USED FOR COSTING

Operation/Waste Stream	Production (kkg/yr)	Flow (l/yr x 10^6)		
		Option 1	Option 2	Option 3
CORE				
Drawing With Neat Oils	16,213	0	0	0
Degreasing Spent Solvent	16,213	0	0	0
Sawing Spent Lubricant	16,213	0.078	0.078	0.078
Miscellaneous Waste Streams	16,213	0.730	0.730	0.730
ANCILLARY				
Continuous Rod Casting Cooling Water	2,026	2.11	0.211	0.211
Continuous Rod Casting Lubricant	2,026	0.004	0.004	0.004
Solution Heat Treatment	5,220	40.22	10.633	10.633
Cleaning or Etching Bath	2,726	0.488	0.488	0.488
Cleaning or Etching Rinse	2,726	37.924	3.792	3.792
Cleaning or Etching Scrubber	2,726	43.343	5.269	5.269

Table VIII-17

CHARACTERISTICS OF THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY NORMAL PLANT USED FOR COSTING

Operation/Waste Stream	Production (kkg/yr)	Flow (l/yr x 10^6)		
		Option 1	Option 2	Option 3
CORE				
Drawing Spent Emulsions	6,914	2.88	2.88	2.88
Degreasing Spent Solvent	6,914	0	0	0
Sawing Spent Lubricant	6,914	0.0332	0.0332	0.0332
Miscellaneous Waste Streams	6,914	0.311	0.311	0.311
ANCILLARY				
Continuous Rod Casting Cooling Water	46	0.048	0.0048	0.0048
Continuous Rod Casting Lubricant	46	0.00008	0.00008	0.00008
Solution Heat Treatment	5,864	45.18	11.94	11.94
Cleaning or Etching Bath	360	0.064	0.064	0.064
Cleaning or Etching Rinse	360	5.008	0.501	0.501
Cleaning or Etching Scrubber	360	5.72	0.70	0.70

Table VIII-18

SUMMARY OF THE ALUMINUM FORMING NORMAL PLANT COSTS ($1982)

Subcategory	Plant Core Production (kkg/yr)	Cost of Compliance[a] ($1982)					
		Option 1		Option 2		Option 3	
		Capital[b]	Annual[c]	Capital[b]	Annual[c]	Capital[b]	Annual[c]
Rolling With Neat Oils	166,710	1,023,495	1,134,182	907,527	1,000,567	944,556	1,025,521
Rolling With Emulsions	150,049	1,455,355	1,307,550	1,465,997	1,312,770	1,573,880	1,399,834
Extrusion	19,182	589,215	348,353	585,598	328,140	640,014	361,182
Forging	4,793	553,602	363,483	440,811	293,341	469,810	309,034
Drawing With Neat Oils	16,213	548,652	366,267	466,051	312,101	492,795	328,631
Drawing With Emulsions	6,914	447,727	232,904	402,063	220,935	428,683	237,372

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[a] Option 1: Flow equalization with lime and settle treatment.
Option 2: Flow reduction with lime and settle treatment.
Option 3: Flow reduction with lime, settle, and filter treatment.

[b] The system capital costs are calculated as 37.5 percent of the direct capital costs.

[c] The amortization costs are based on a capital recovery factor of 0.177 (assuming an interest rate of return of 12 percent and a taxable lifetime of 10 years).

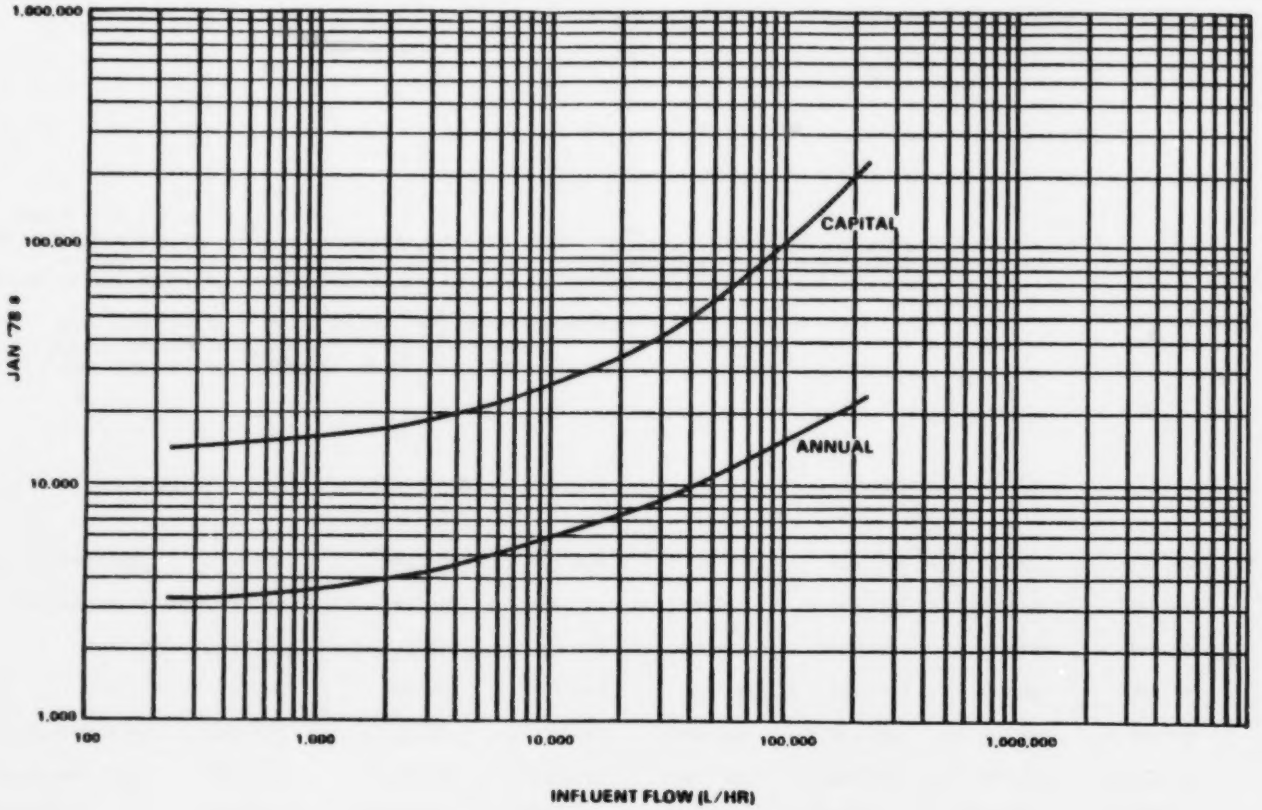


Figure VIII-1

COSTS OF OIL SKIMMING (PRE-PROPOSAL)

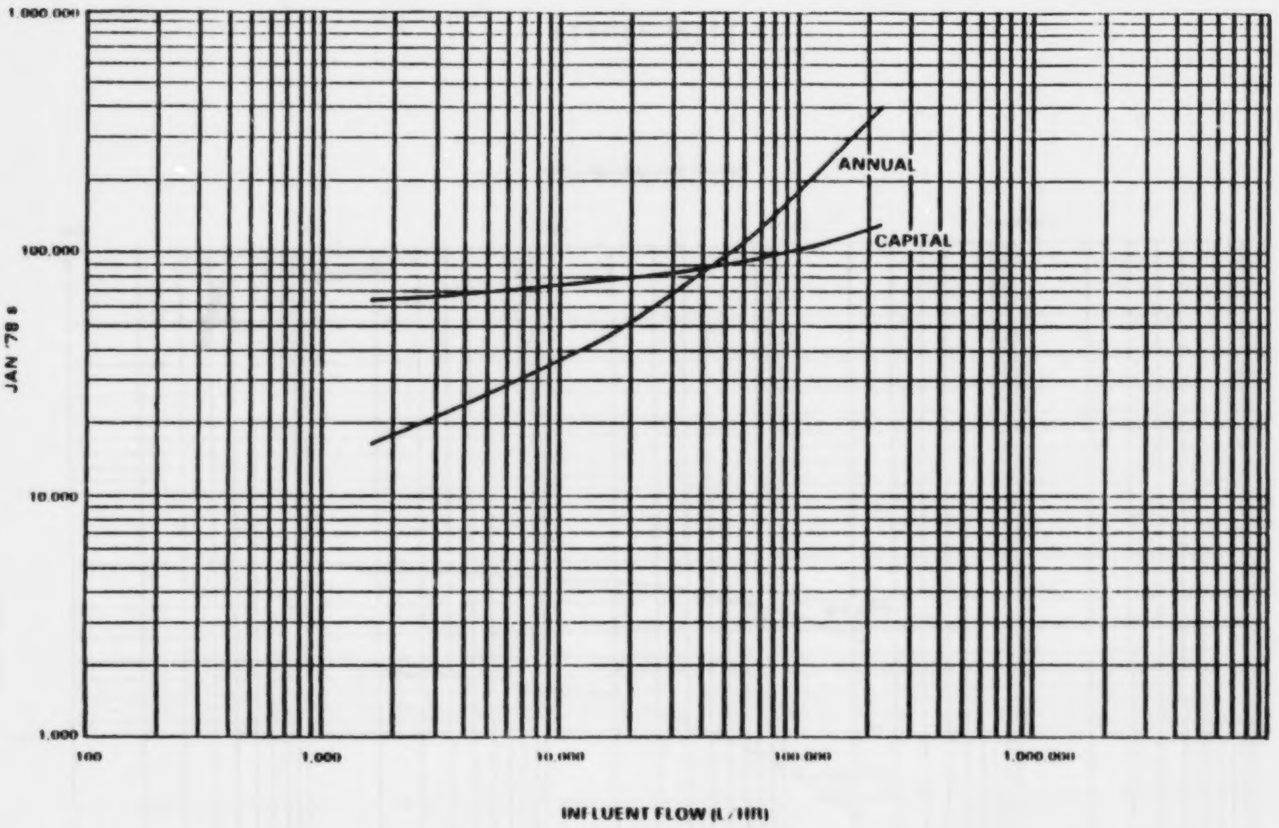


Figure VIII-2

COSTS OF CHEMICAL EMULSION BREAKING (PRE-PROPOSAL)

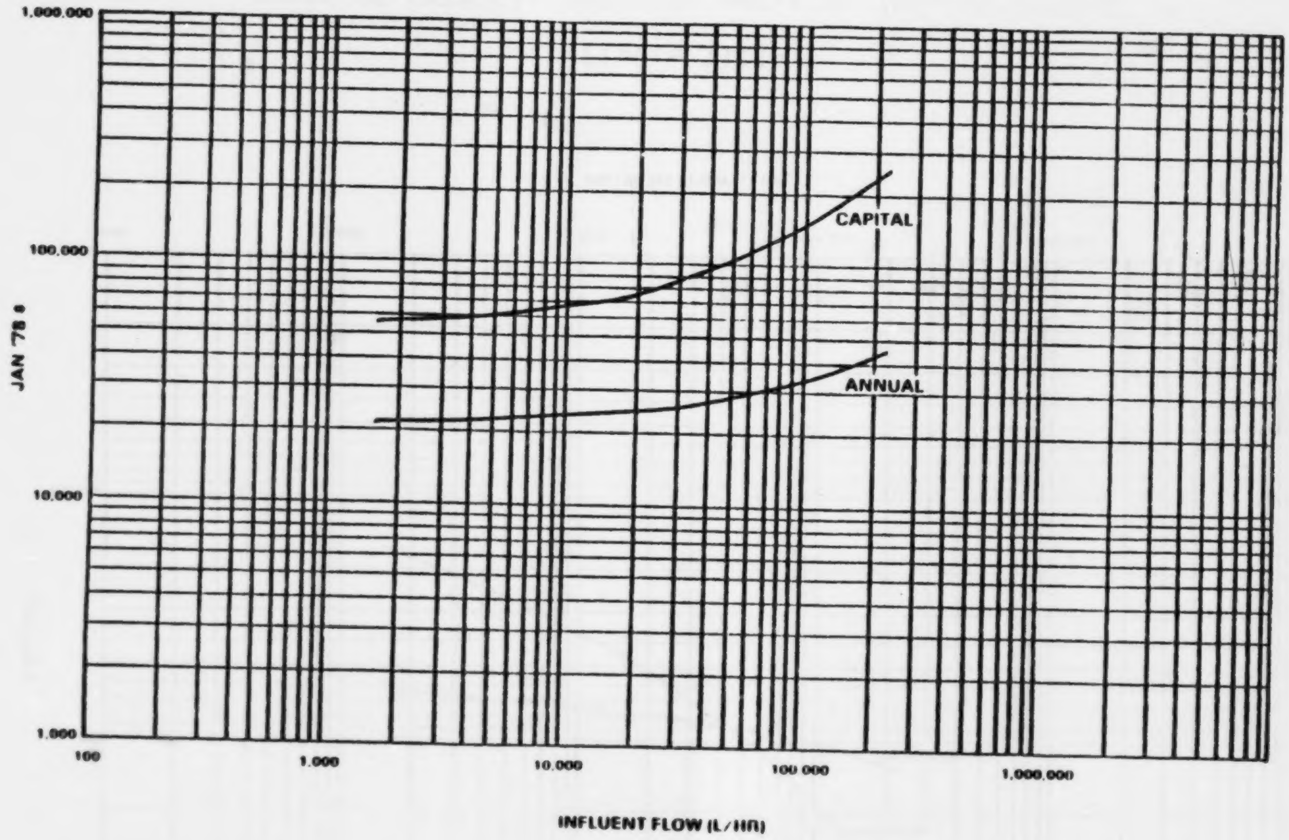


Figure VIII-3

COSTS OF DISSOLVED AIR FLOTATION (PRE-PROPOSAL)

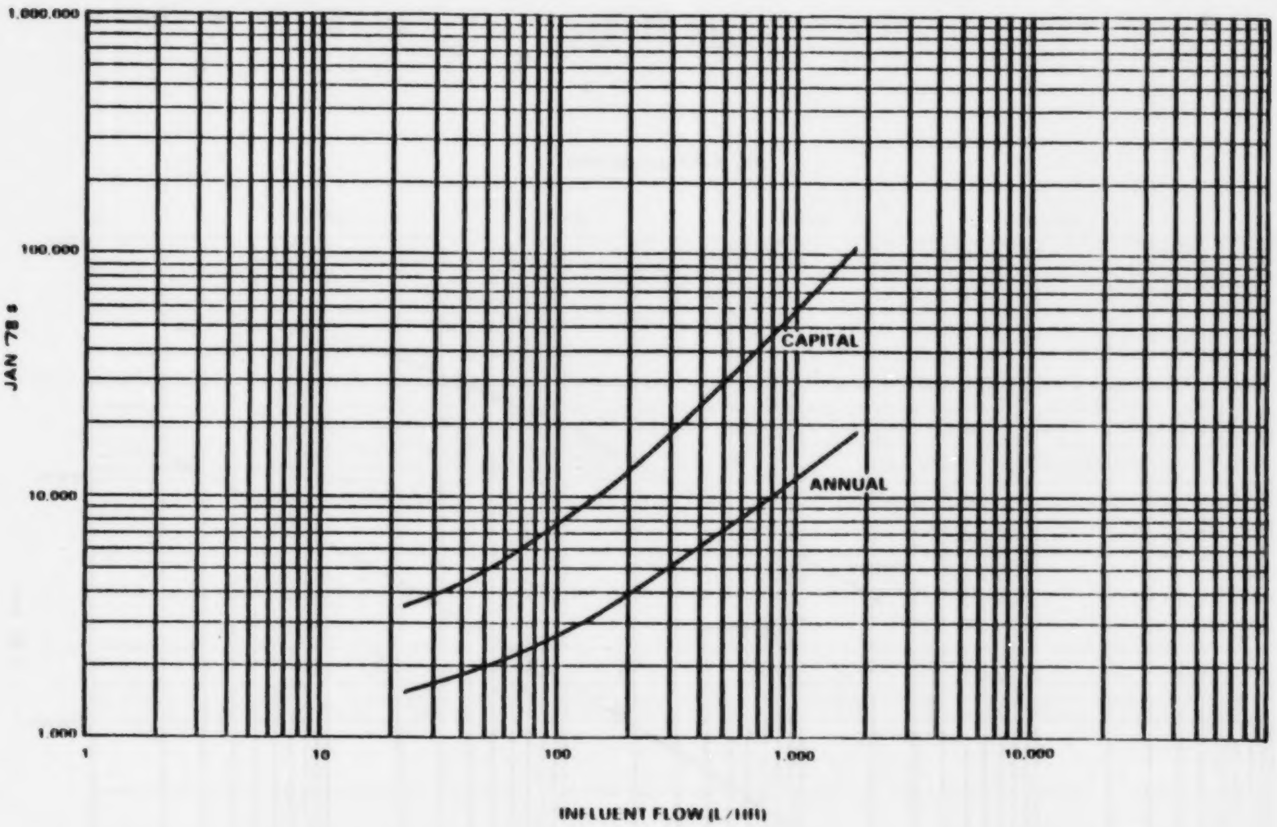


Figure VIII-4

COSTS OF THERMAL EMULSION BREAKING (PRE-PROPOSAL)

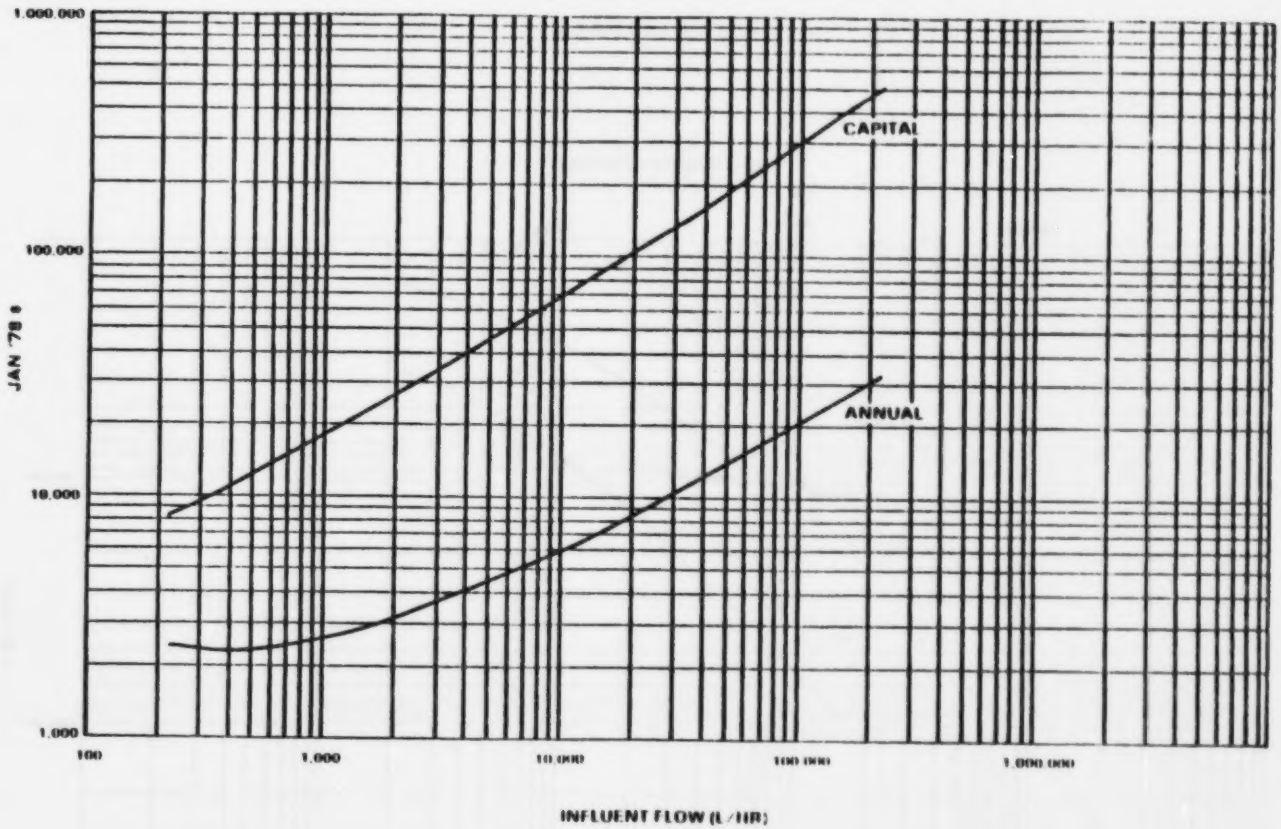


Figure VIII-5

COSTS OF MULTIMEDIA FILTRATION (PRE-PROPOSAL)

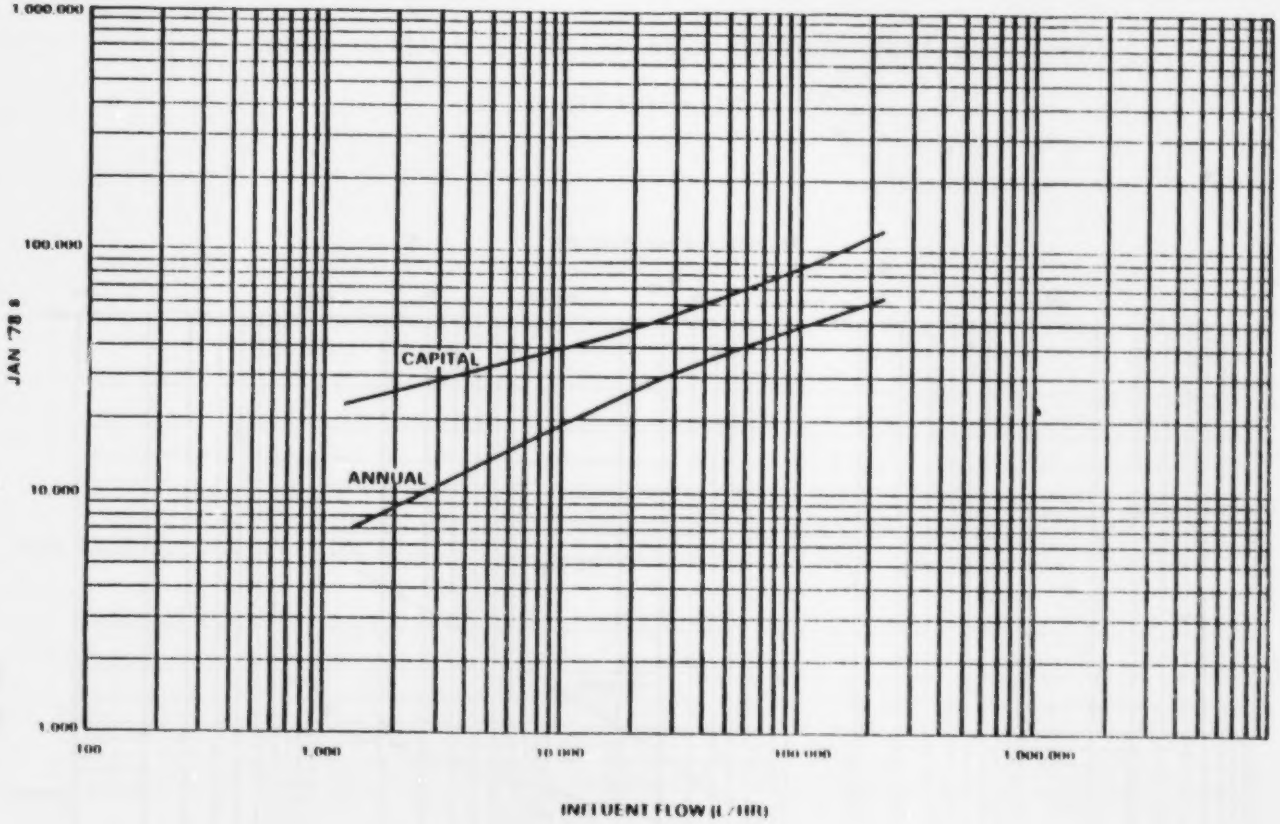


Figure VIII-6

COSTS OF PH ADJUSTMENT WITH ACID (PRE-PROPOSAL)

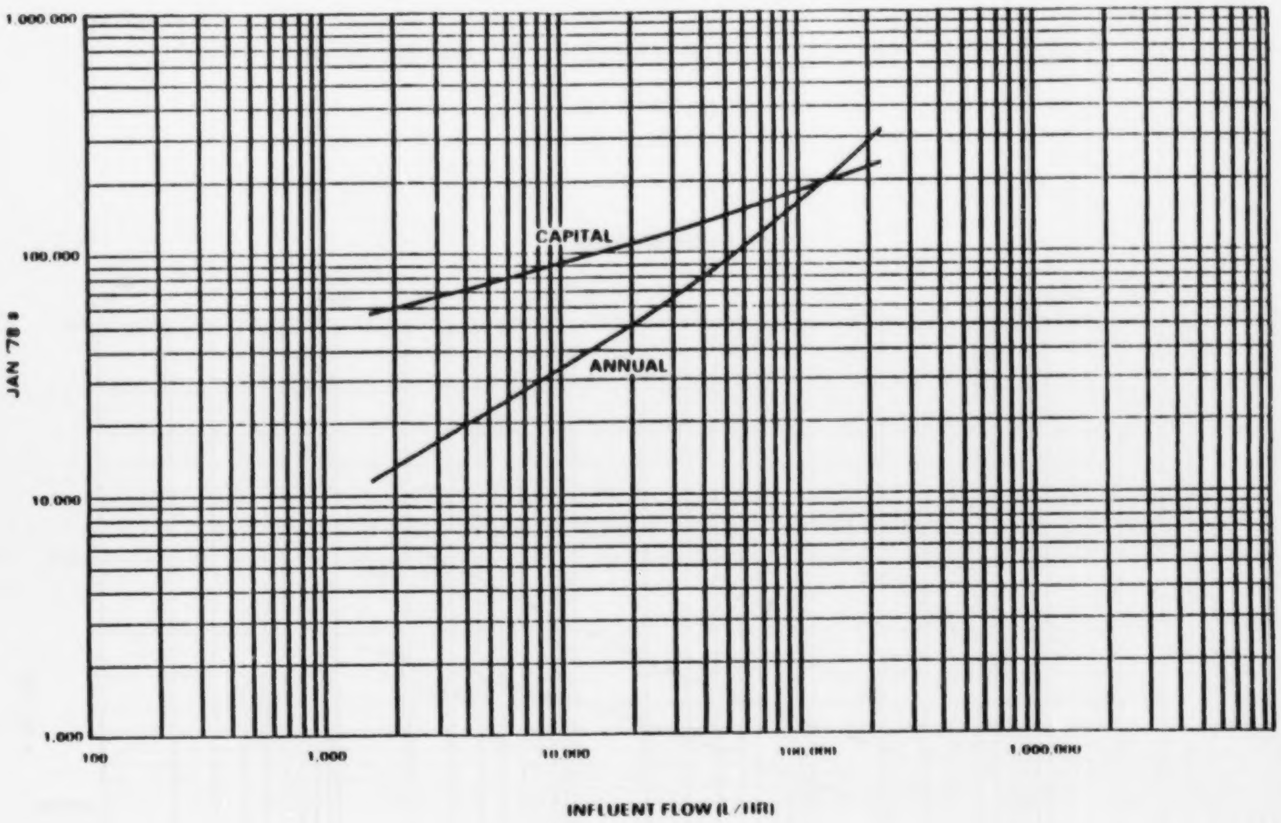


Figure VIII-7

COSTS OF PH ADJUSTMENT WITH CAUSTIC (PRE-PROPOSAL)

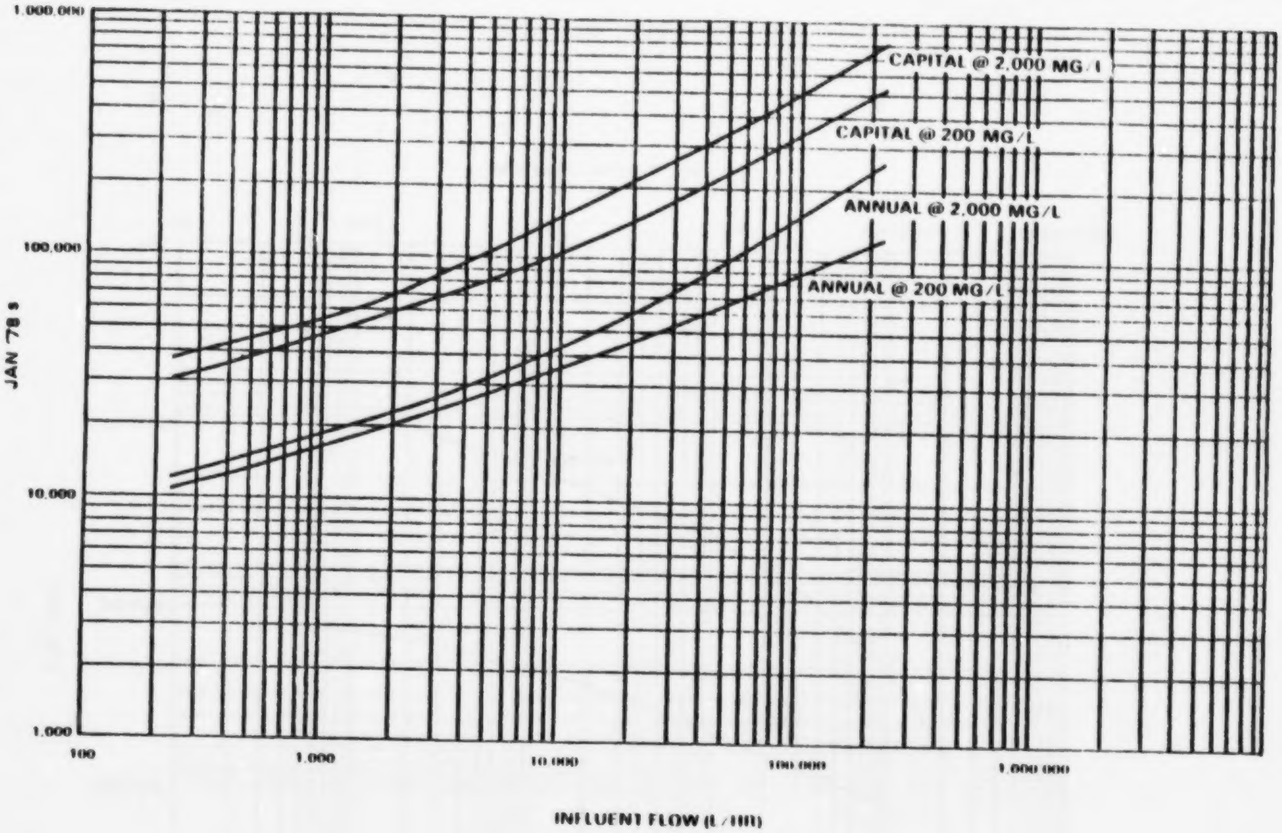


Figure VIII-8

COSTS OF LIME AND SETTLE (PRE-PROPOSAL)

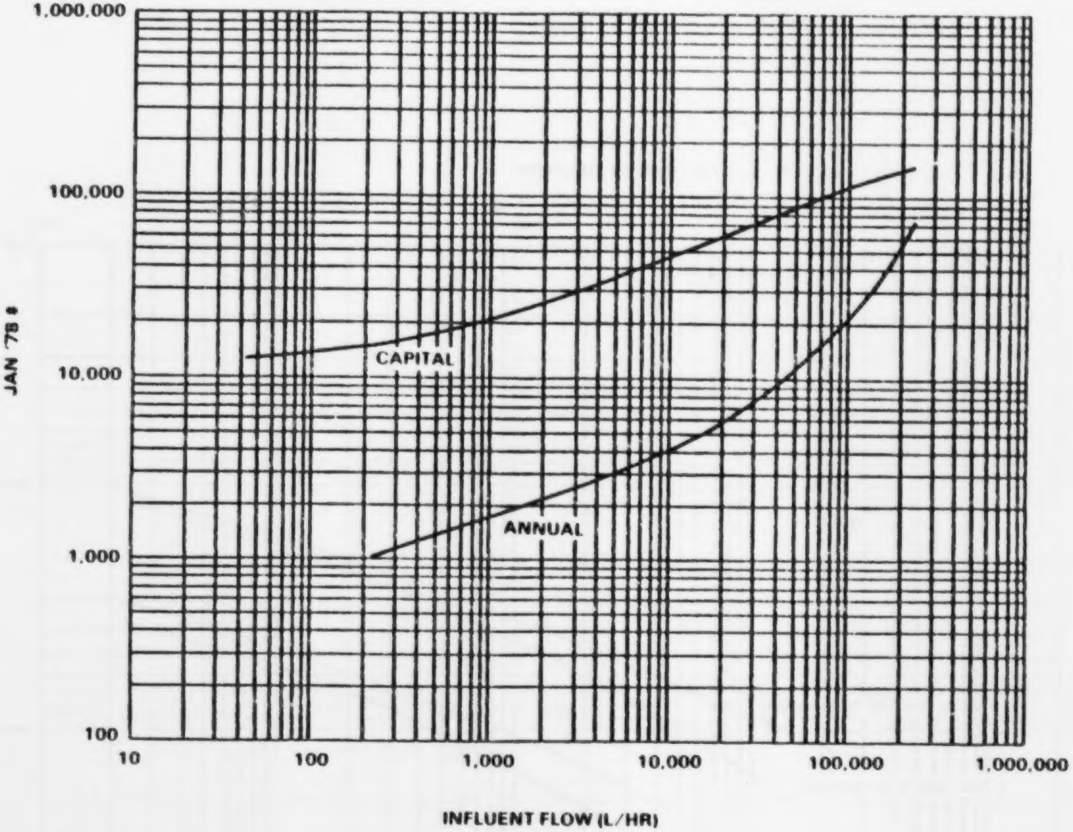


Figure VIII-9

COSTS OF CHROMIUM REDUCTION (PRE-PROPOSAL)

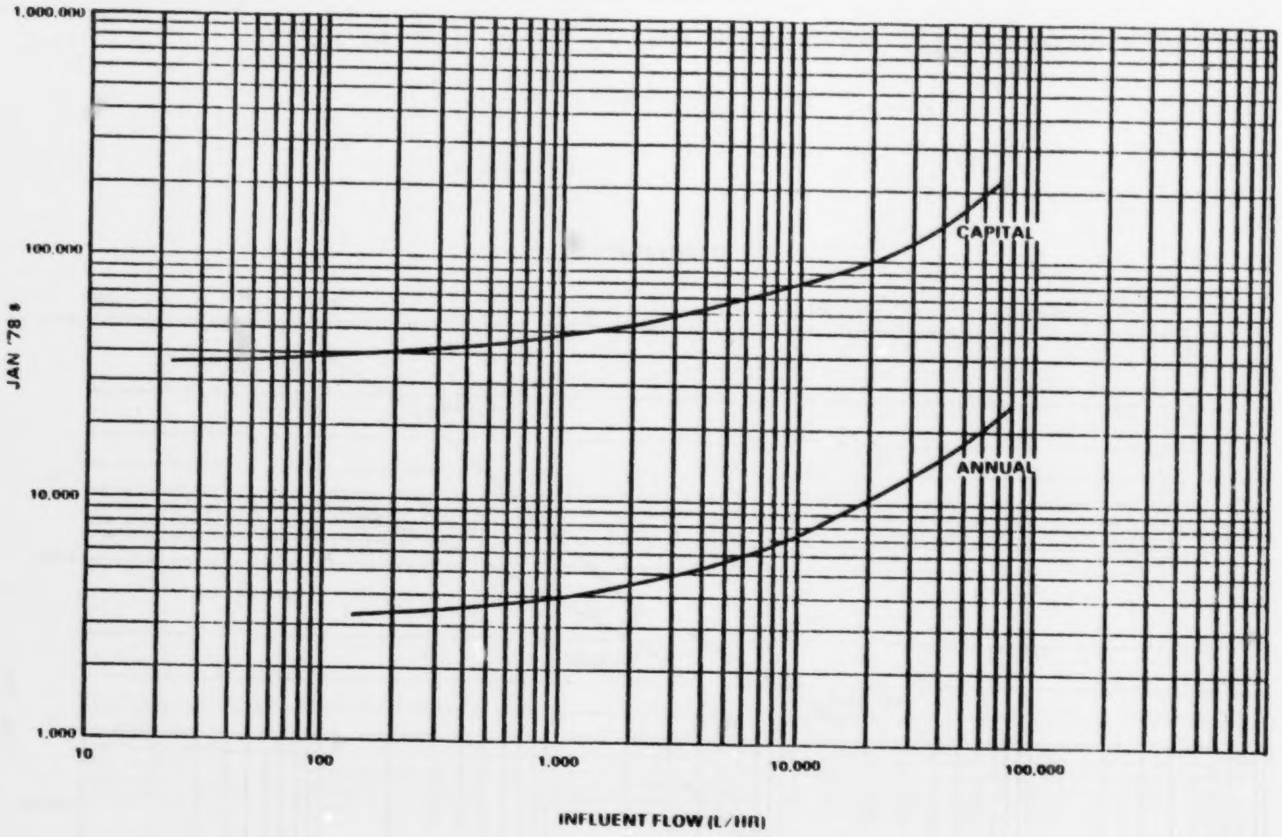


Figure VIII-10

COSTS OF CYANIDE OXIDATION (PRE-PROPOSAL)

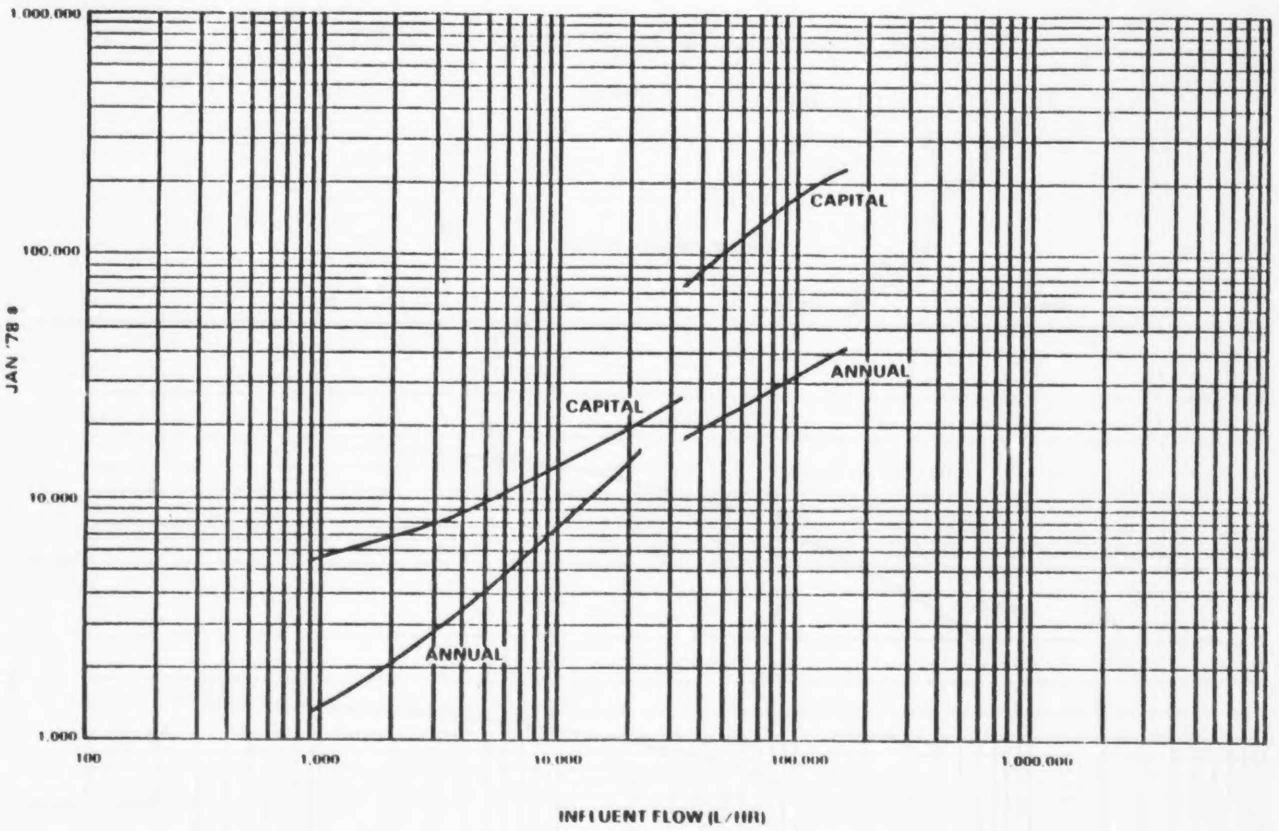


Figure VIII-11

COSTS OF ACTIVATED CARBON ADSORPTION (PRE-PROPOSAL)

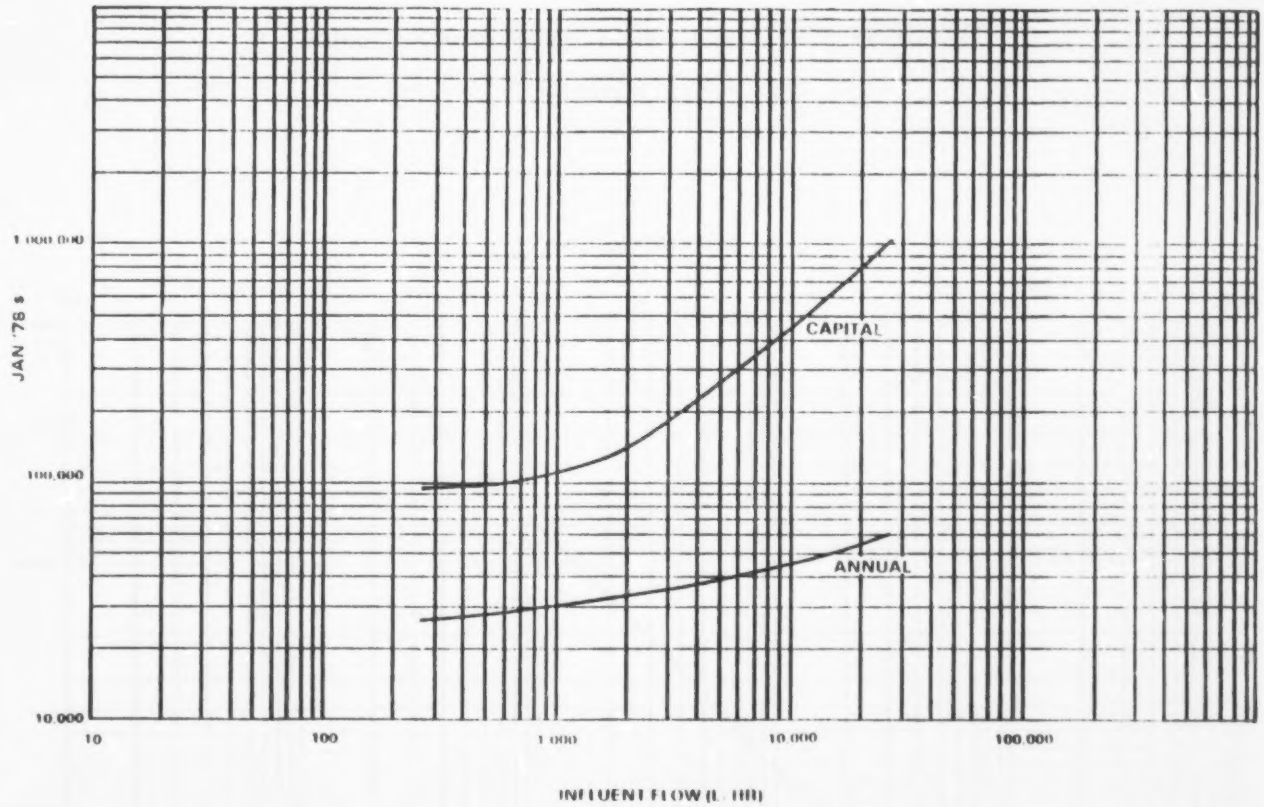


Figure VIII-15

COSTS OF VACUUM FILTRATION (PRE-PROPOSAL)

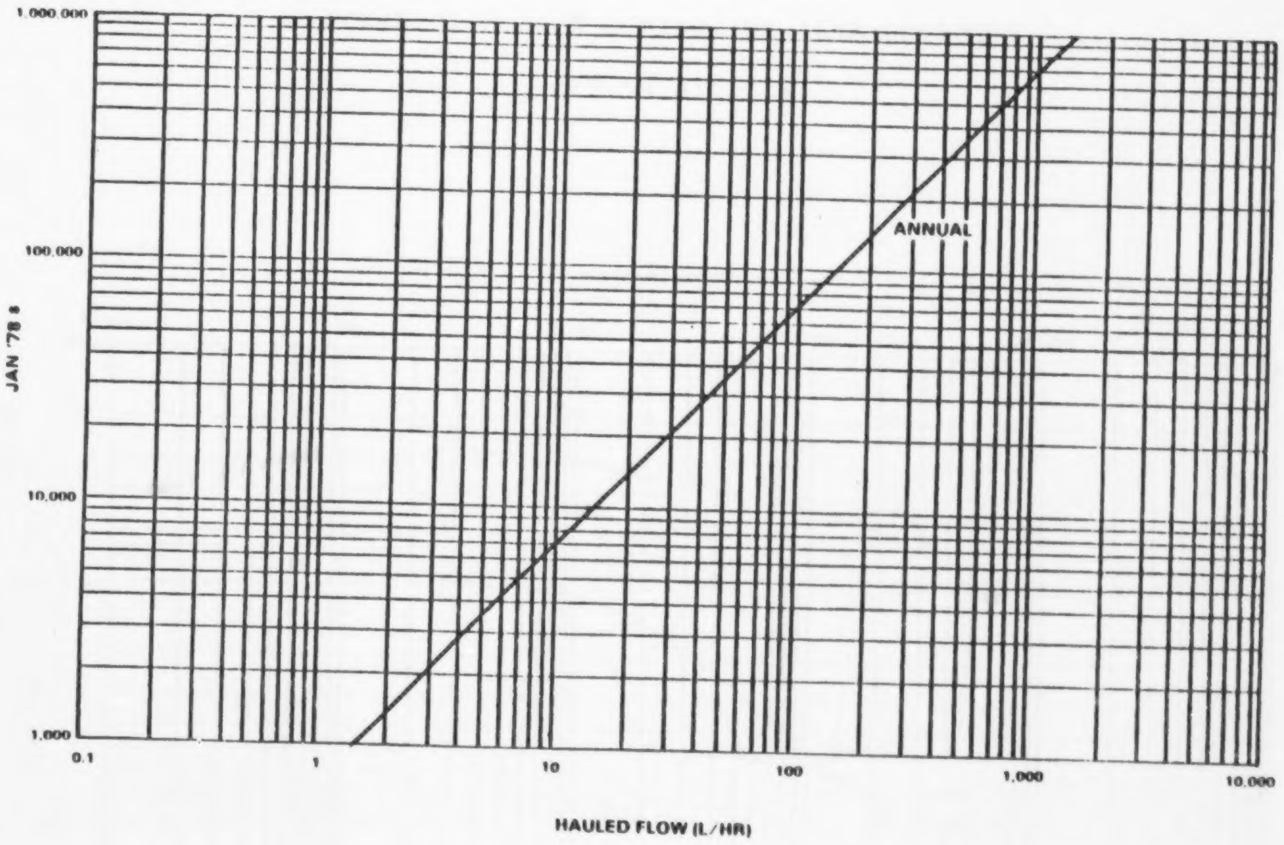


Figure VIII-13

COSTS OF CONTRACT HAULING (PRE-PROPOSAL)

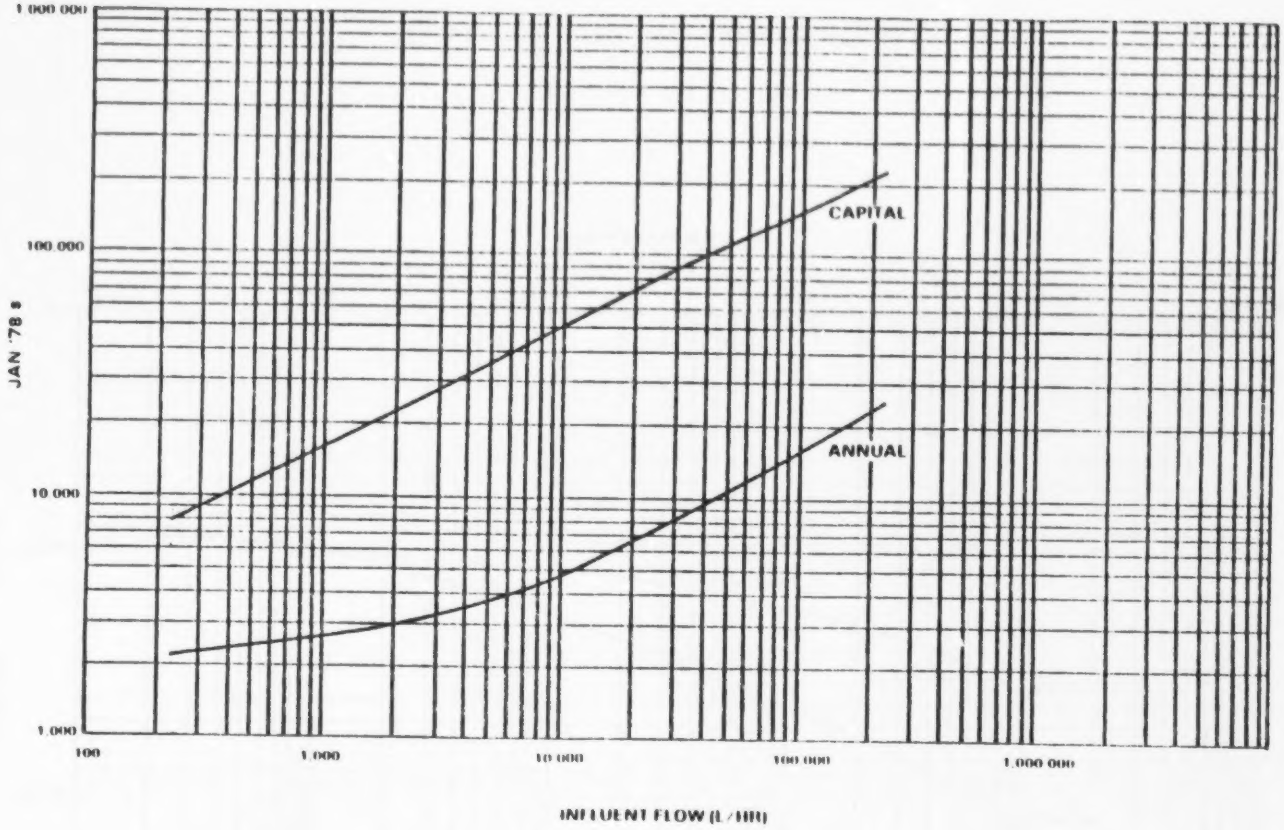


Figure VIII-14

COSTS OF FLOW EQUALIZATION (PRE-PROPOSAL)

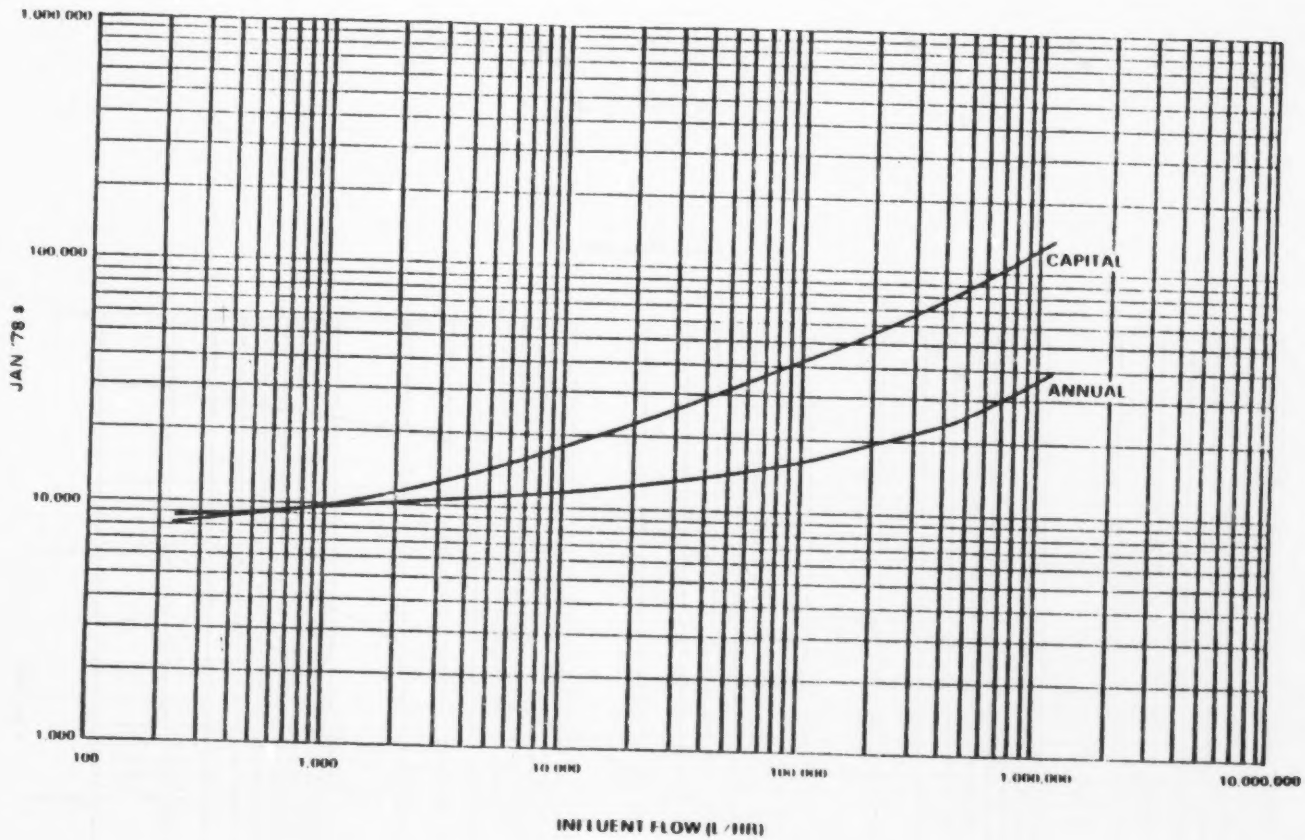
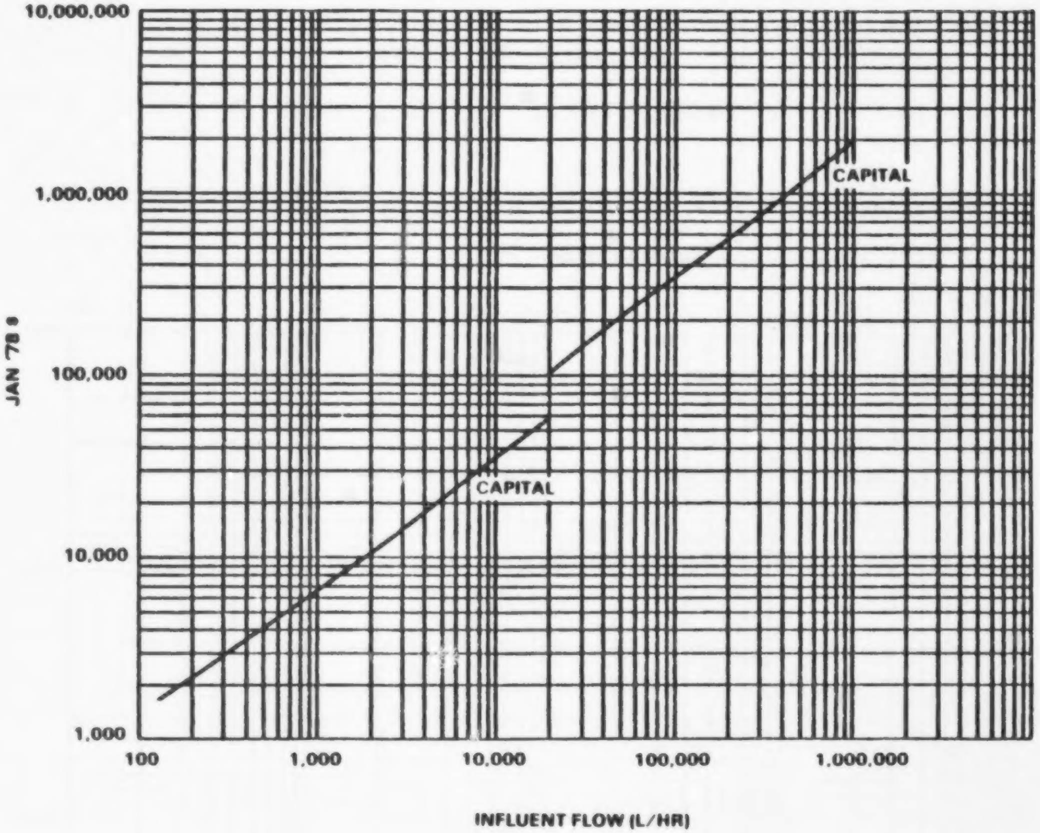


Figure VIII-15

COSTS OF PUMPING (PRE-PROPOSAL)



*BASED ON 4 HR RETENTION TIME

Figure VIII-16

COSTS OF HOLDING TANKS (PRE-PROPOSAL)

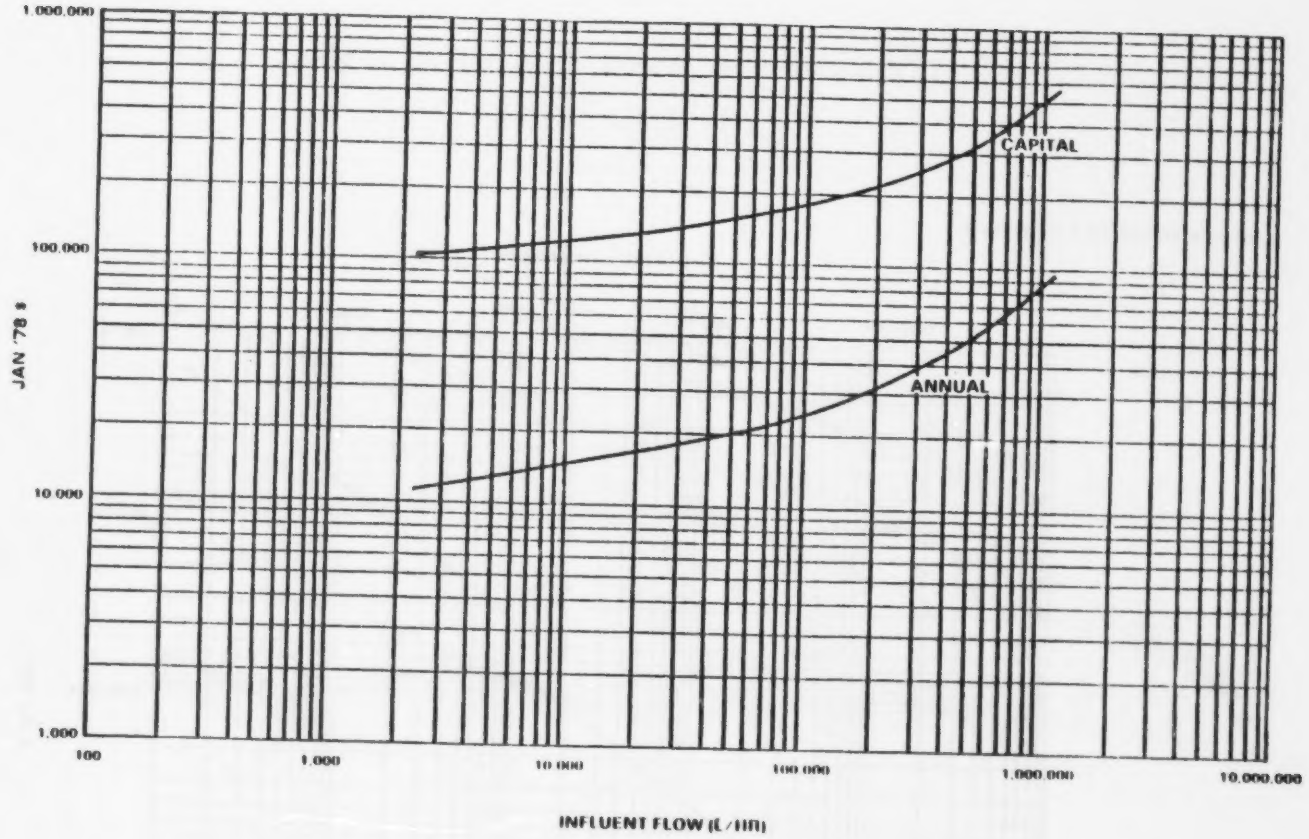


Figure VIII-17

COSTS OF RECYCLING (PRE-PROPOSAL)

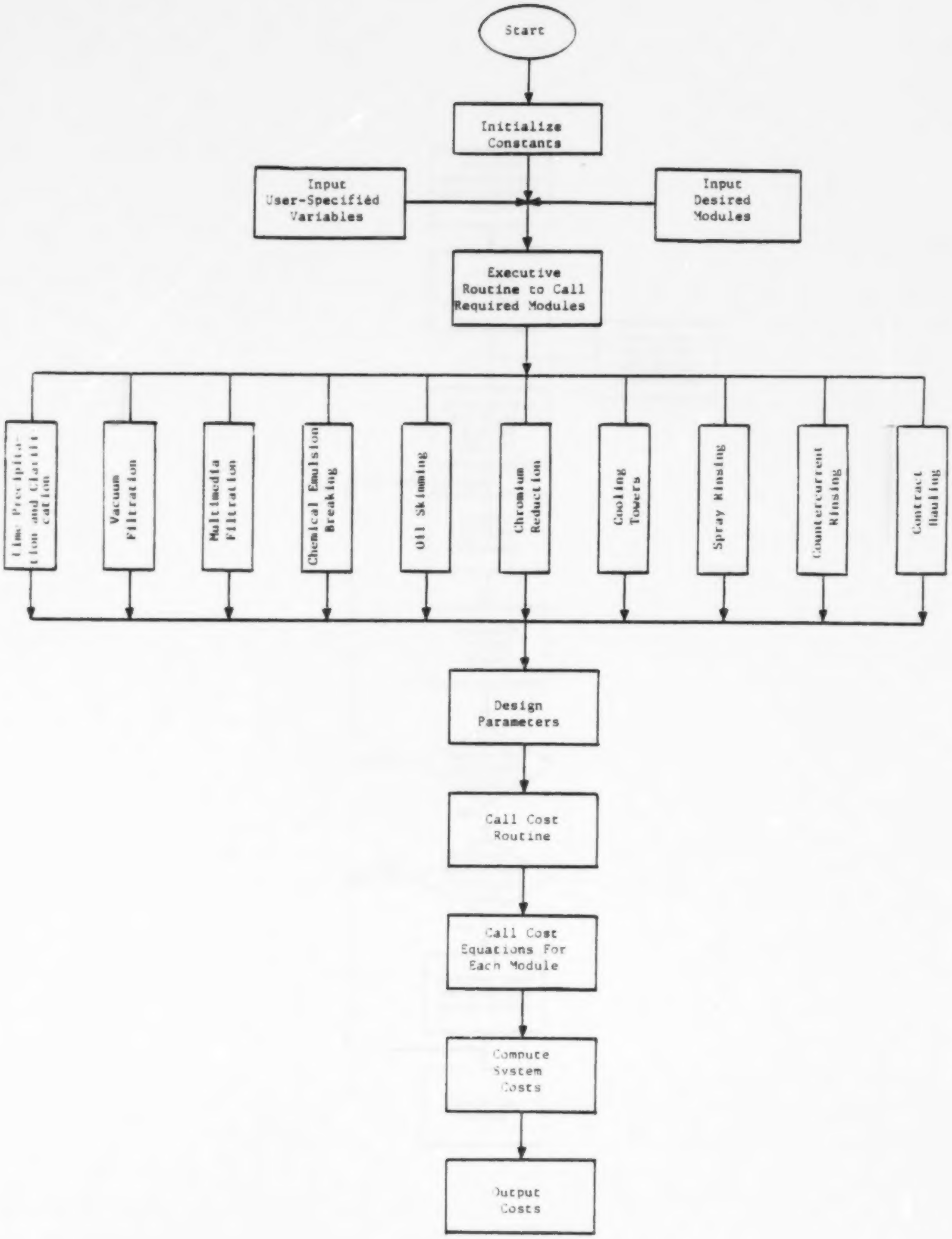


Figure VIII-18

GENERAL LOGIC DIAGRAM OF COMPUTER COST MODEL

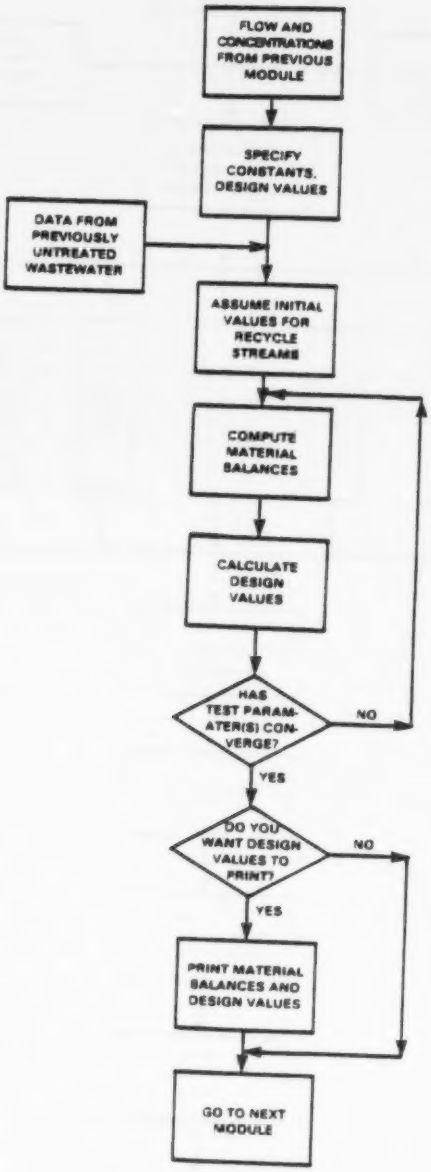

FLOW AND CONCENTRATIONS FROM PREVIOUS MODULE
SPECIFY CONSTANTS, DESIGN VALUES
DATA FROM PREVIOUSLY UNTREATED WASTEWATER
ASSUME INITIAL VALUES FOR RECYCLE STREAMS
COMPUTE MATERIAL BALANCES
CALCULATE DESIGN VALUES
HAS TEST PARAMATER(S) CONVERGE?
NO
YES
DO YOU WANT DESIGN VALUES TO PRINT?
NO
YES
PRINT MATERIAL BALANCES AND DESIGN VALUES
GO TO NEXT MODULE

Figure VIII-19

LOGIC DIAGRAM OF MODULE DESIGN PROCEDURE

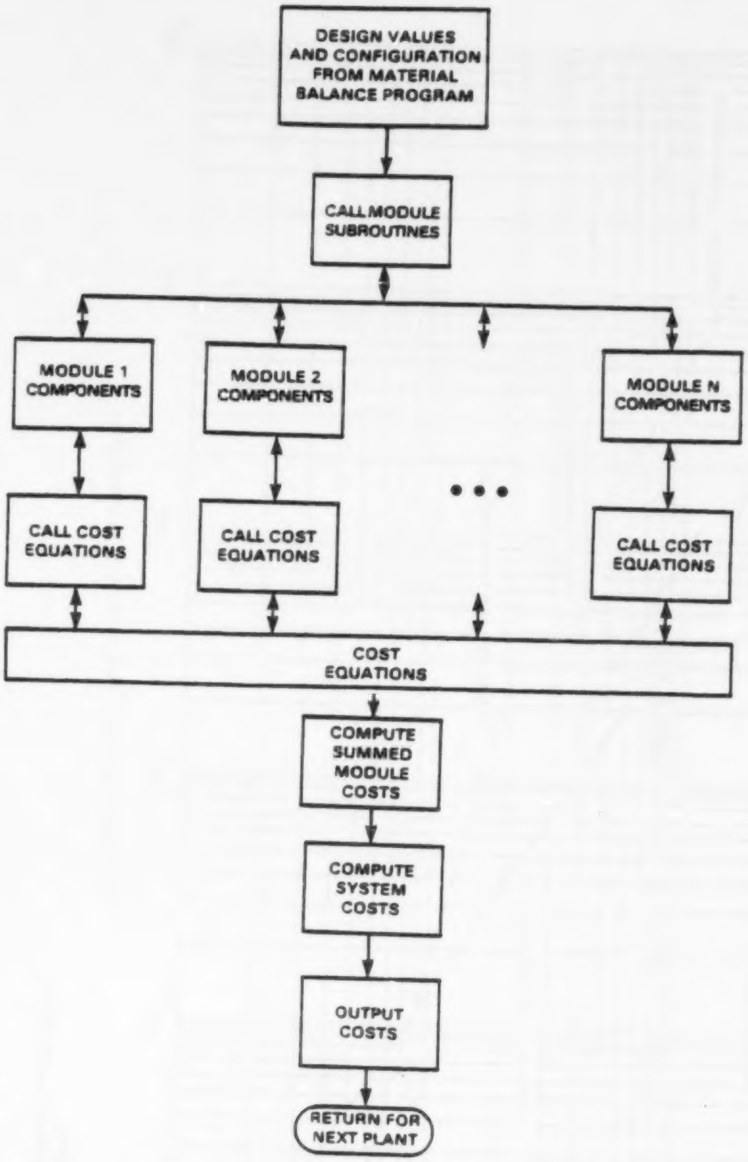
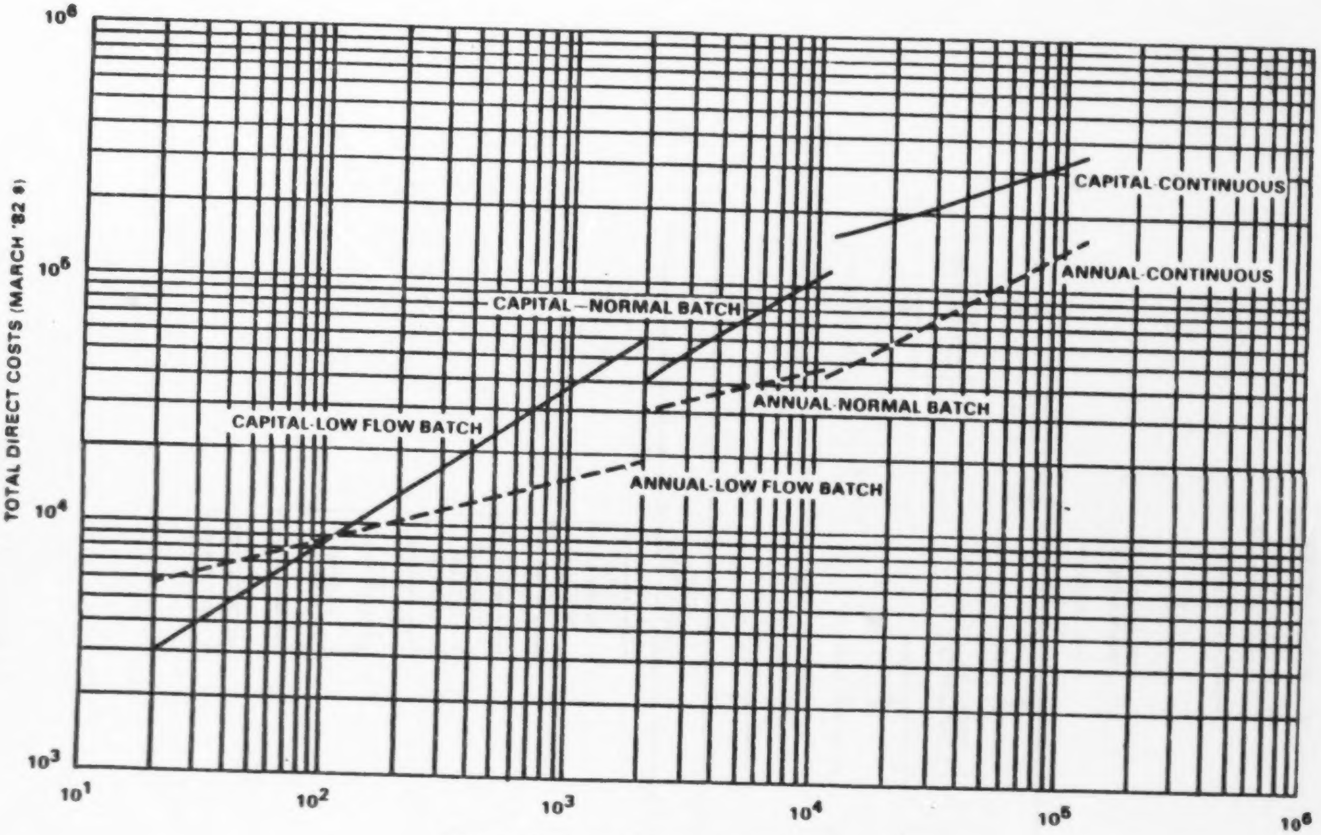


Figure VIII-20

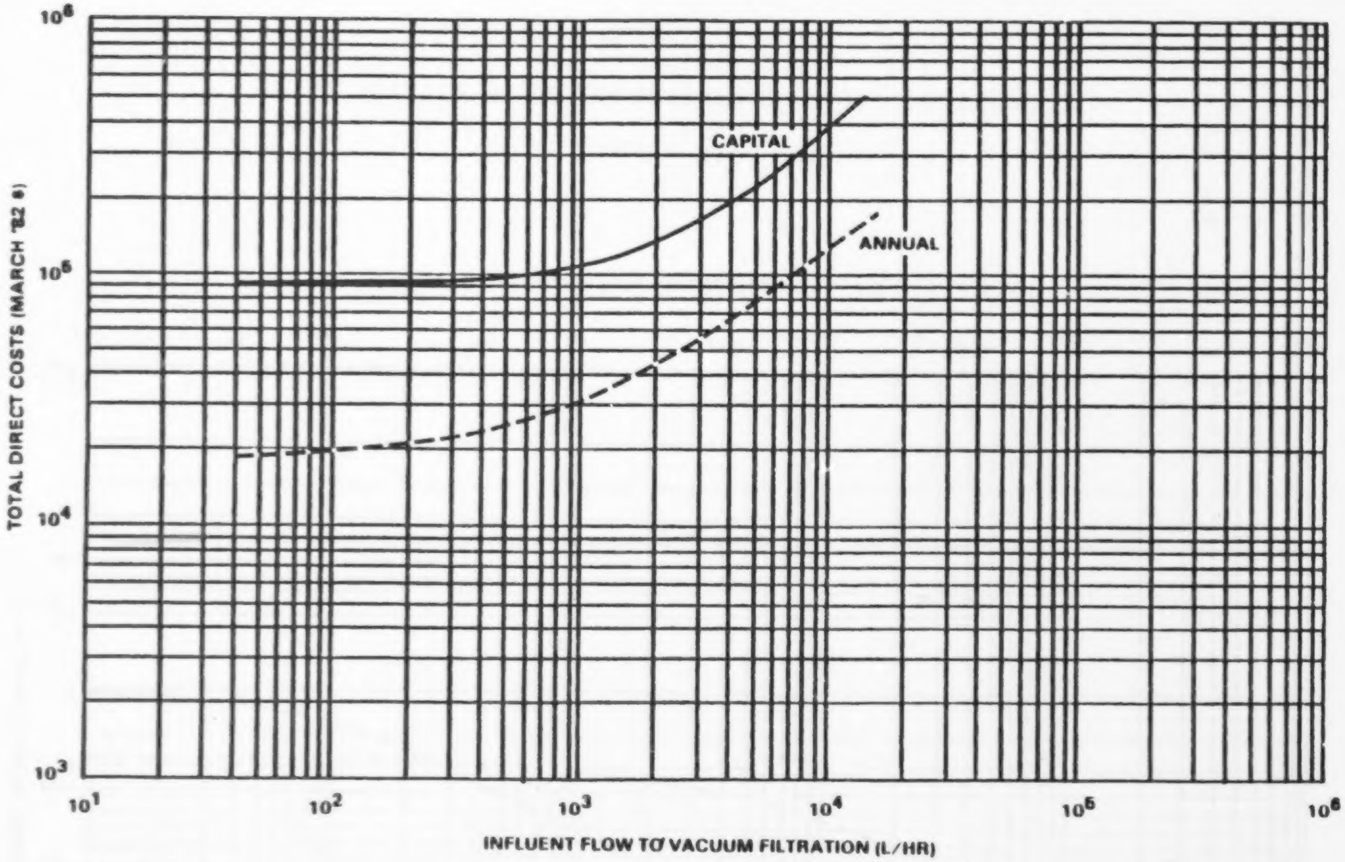
LOGIC DIAGRAM OF THE COSTING ROUTINE



ASSUMPTIONS
1. LIME DOSAGE IS 4,000 MG/L

Figure VIII-21

COSTS OF CHEMICAL PRECIPITATION AND GRAVITY SETTLING (POST-PROPOSAL)



ASSUMPTIONS

1. VACUUM FILTER IS OPERATED 8 HOURS/DAY

Figure VIII-22

COSTS OF VACUUM FILTRATION (POST-PROPOSAL)

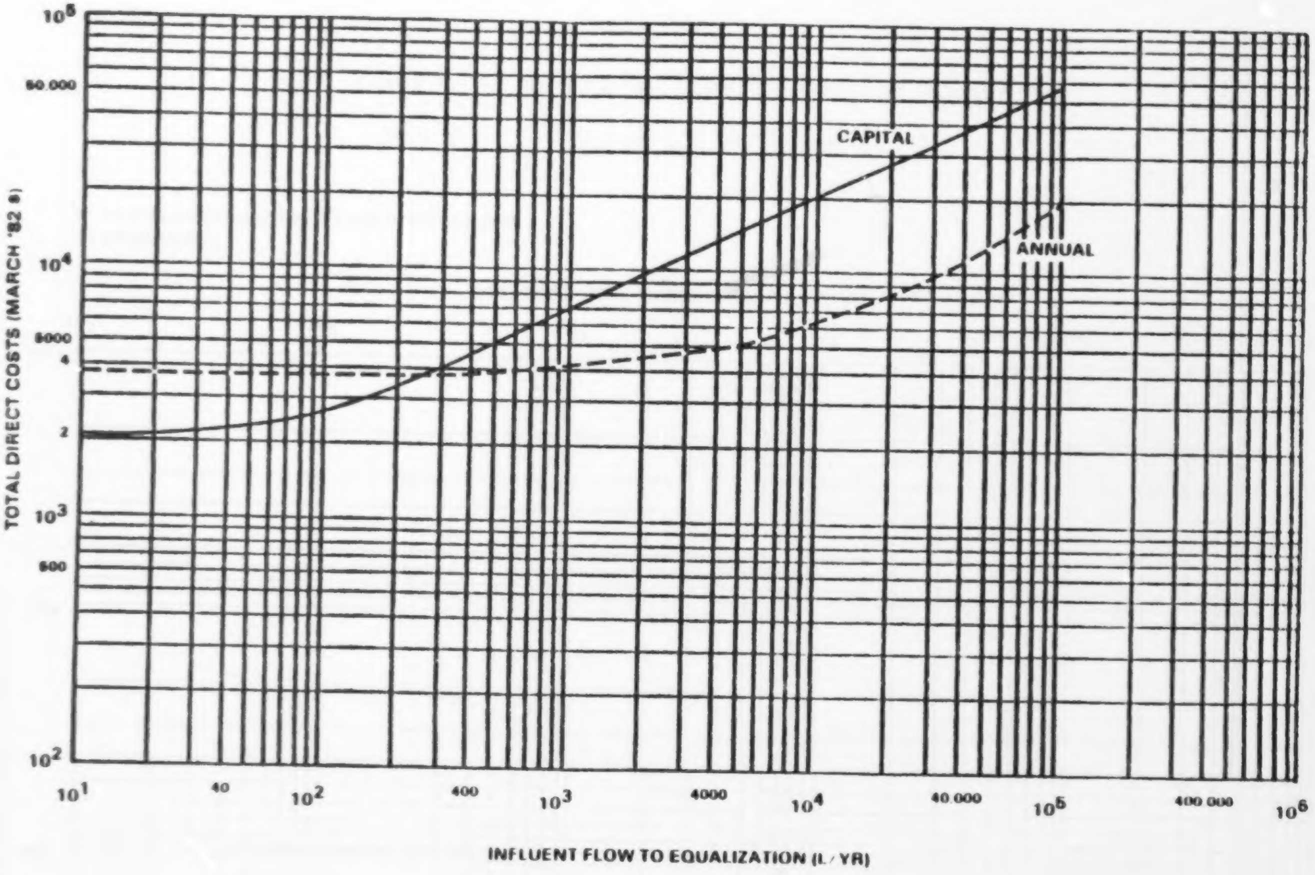


Figure VIII-23

COSTS OF FLOW EQUALIZATION (POST-PROPOSAL)

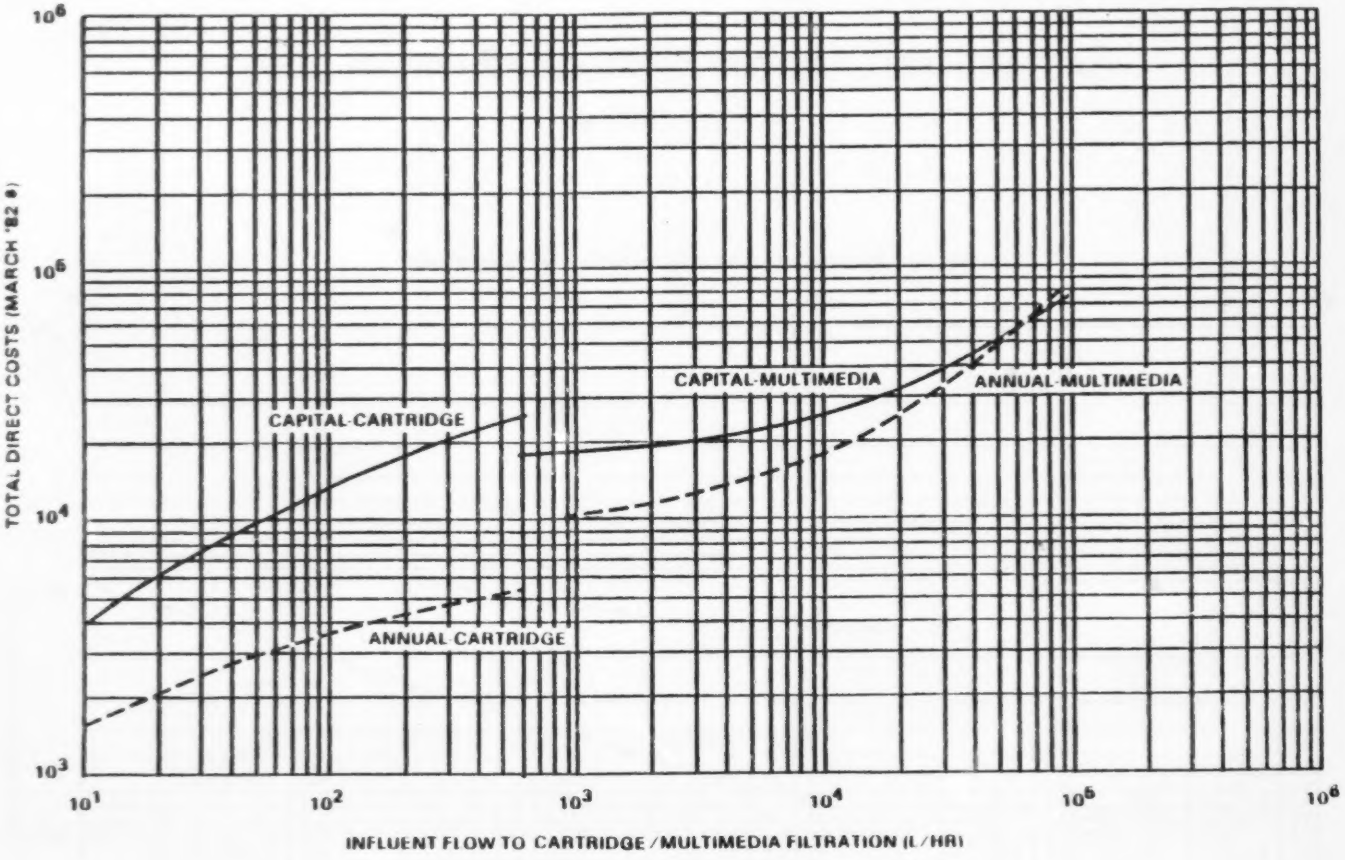


Figure VIII-24

COSTS OF CARTRIDGE/MULTIMEDIA FILTRATION (POST-PROPOSAL)

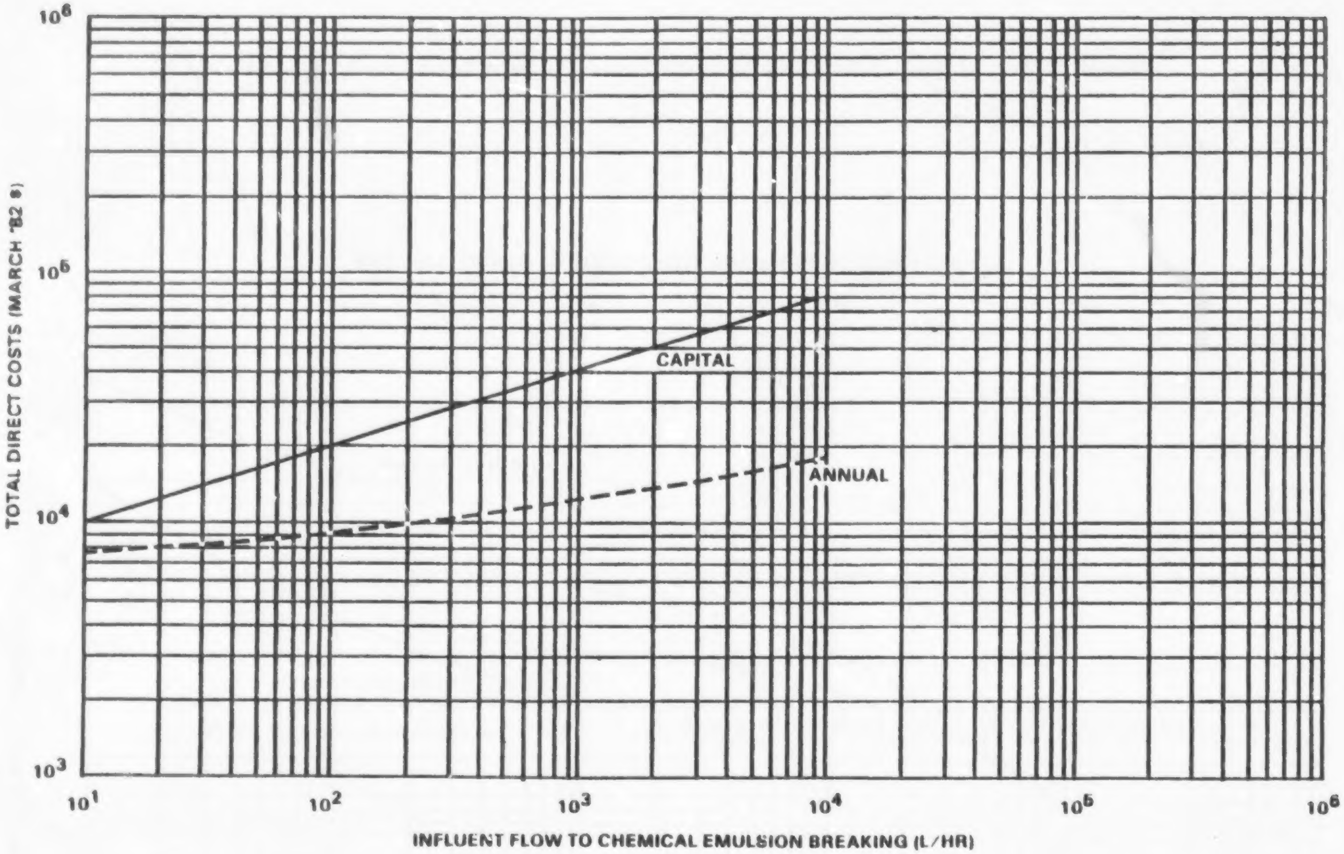


Figure VIII-25

COSTS OF CHEMICAL EMULSION BREAKING (POST-PROPOSAL)

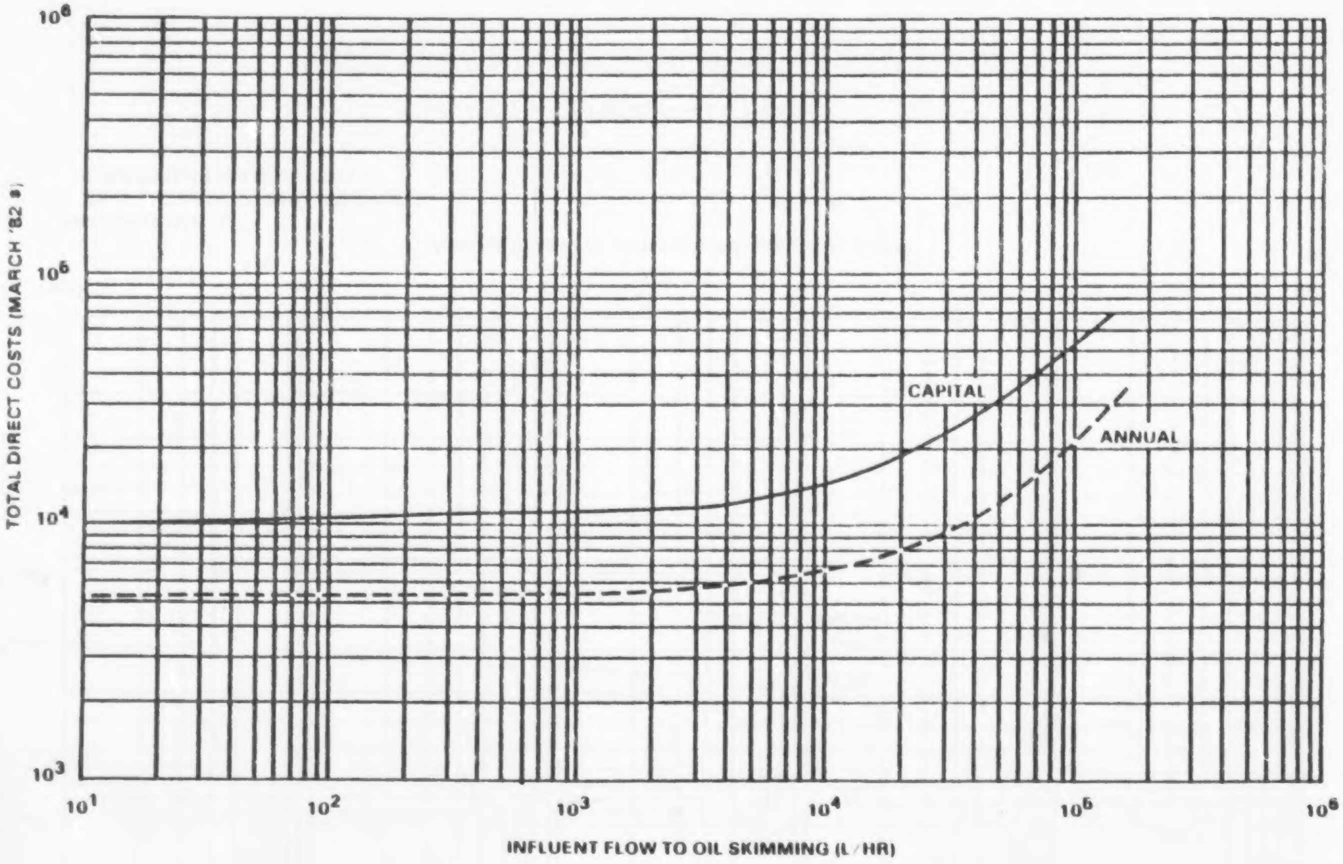
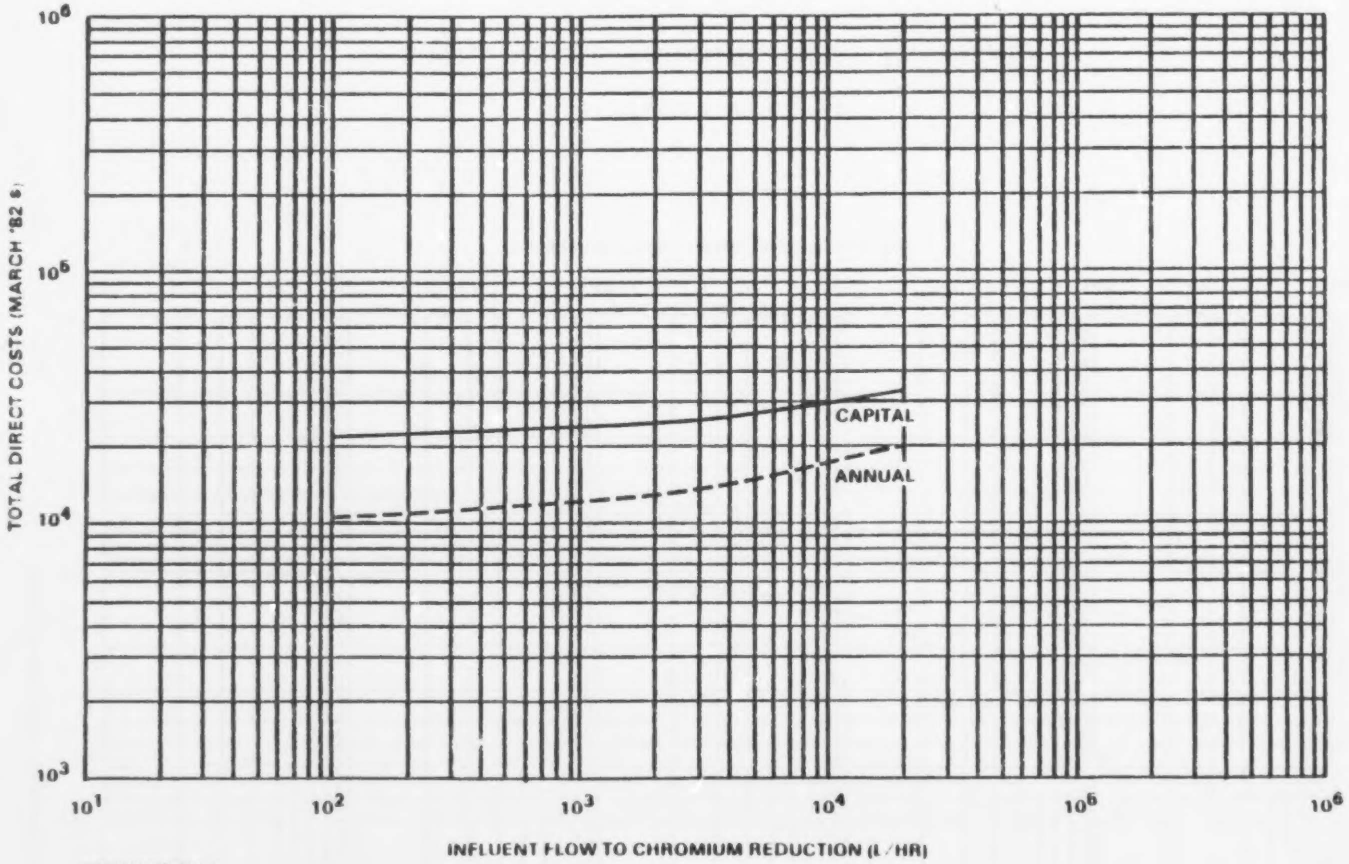


Figure VIII-26

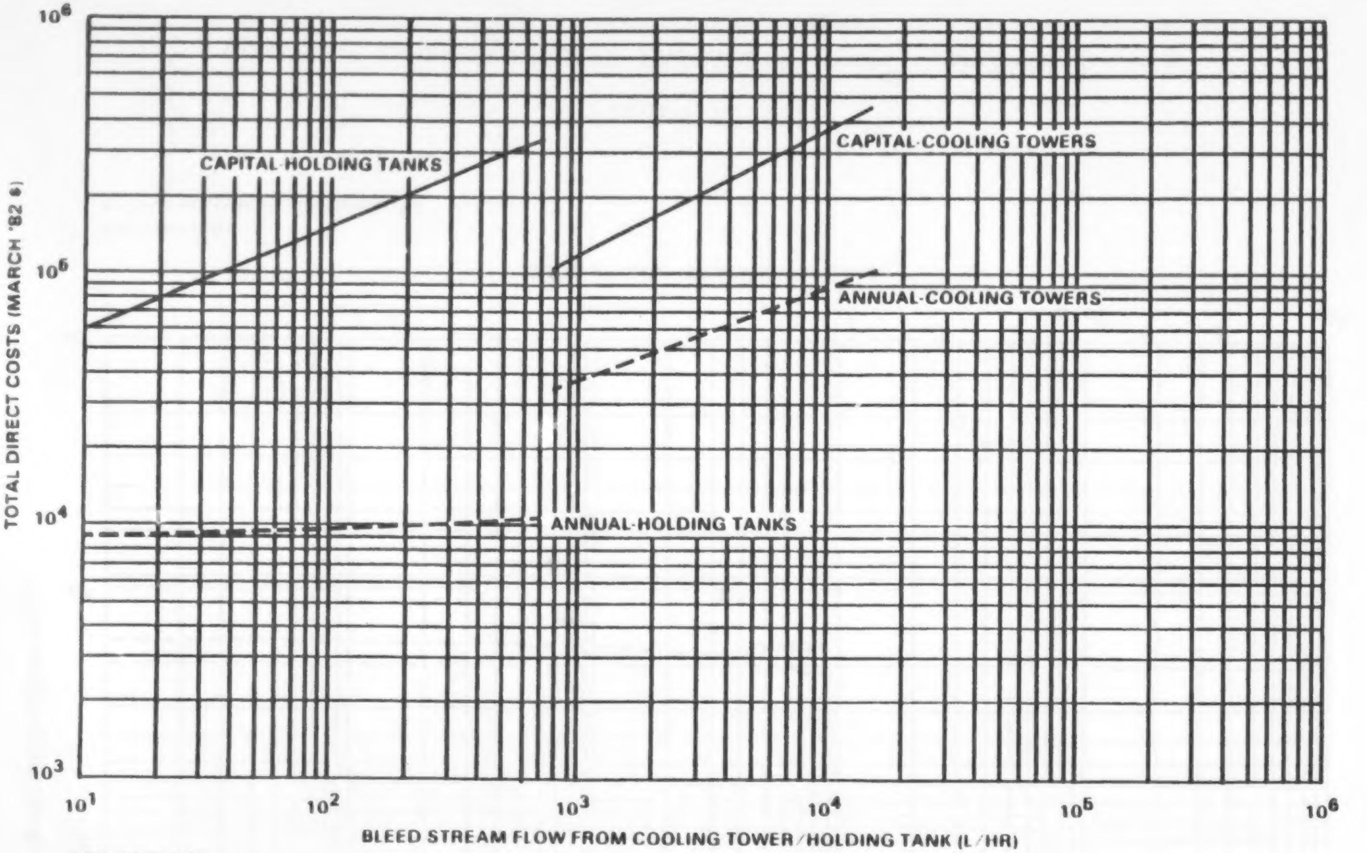
COSTS OF OIL SKIMMING (POST-PROPOSAL)



ASSUMPTIONS
1 INFLUENT HEXAVALENT CHROMIUM
CONCENTRATION IS 60 MG/L

Figure VIII-27

COSTS OF CHROMIUM REDUCTION (POST-PROPOSAL)

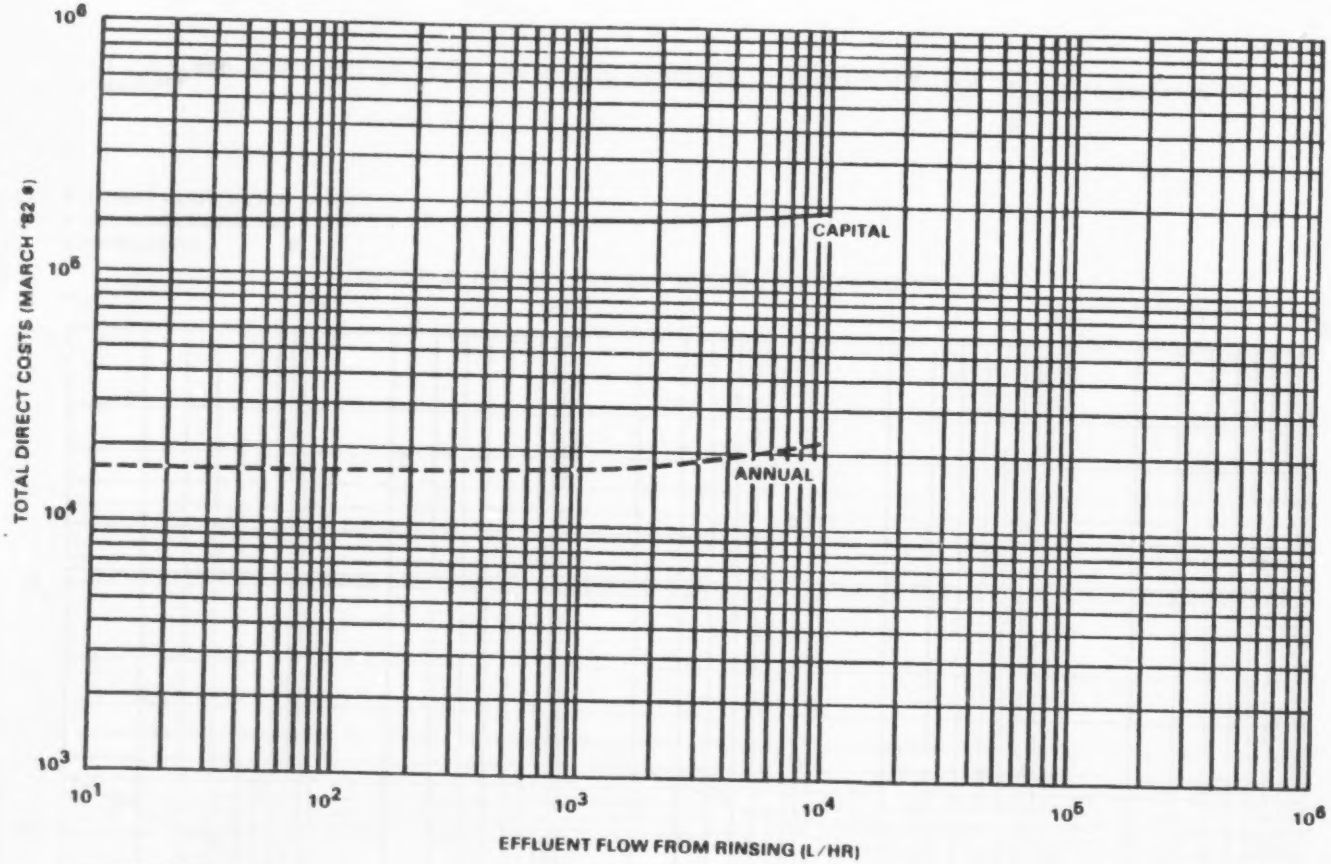


ASSUMPTIONS

1. RECYCLE RATE IS 0.85
2. TEMPERATURE RANGE IS 10° F

Figure VIII-28

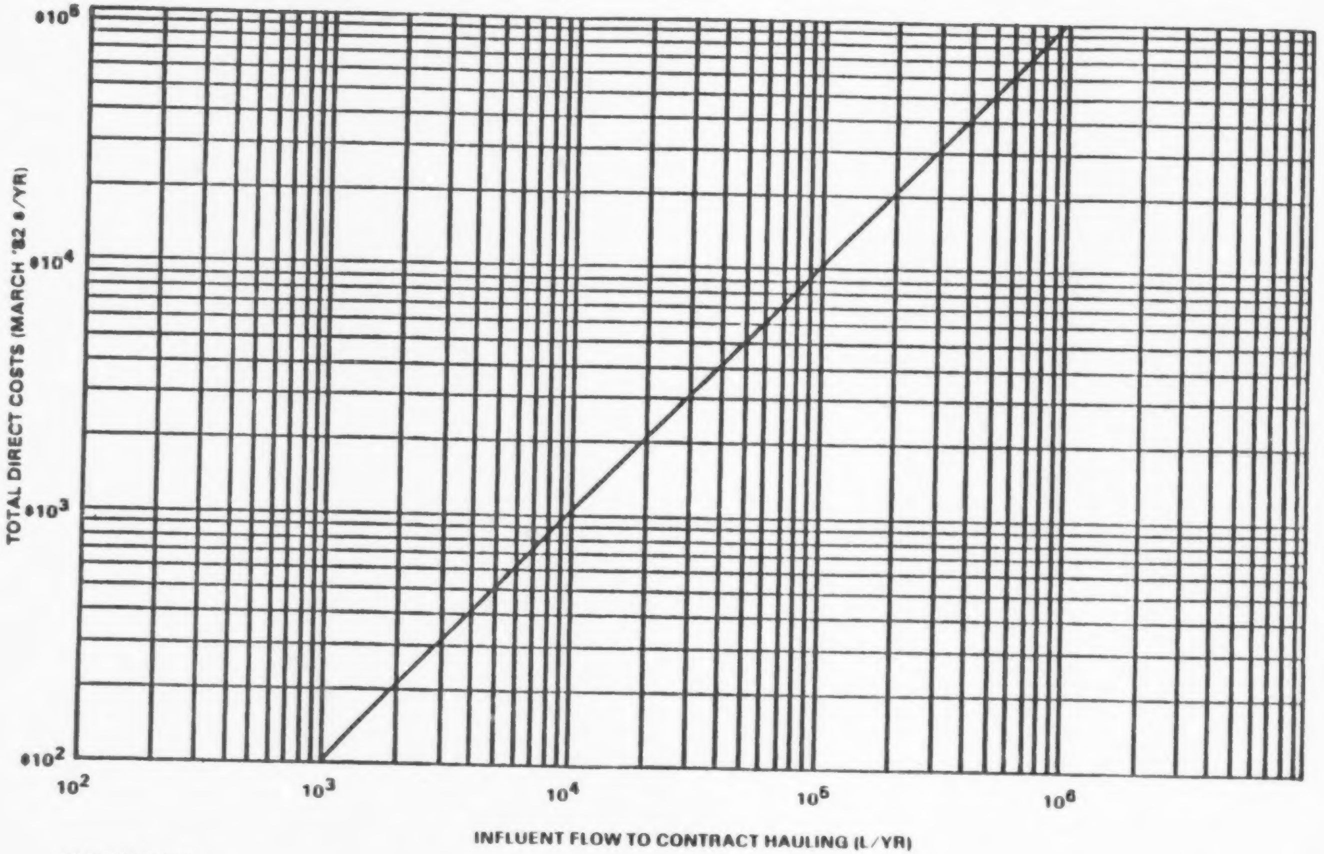
COSTS OF RECYCLING VIA COOLING TOWERS/HOLDING TANKS (POST-PROPOSAL)



ASSUMPTIONS
1. TANK VOLUME IS 3600 GALLONS

Figure VIII-29

COSTS OF COUNTERCURRENT CASCADE RINSING (POST-PROPOSAL)



ASSUMPTIONS

1. OPERATING SCHEDULE IS 16 HOURS PER DAY AND 250 DAYS PER YEAR

Figure VIII-30

COSTS OF CONTRACT HAULING (POST-PROPOSAL)

SECTION IX

BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

This section defines the effluent characteristics attainable through the application of best practicable control technology currently available (BPT), Section 301(b)(1)(A). BPT reflects the existing performance by plants of various sizes, ages, and manufacturing processes within the aluminum forming category, as well as the established performance of the recommended BPT systems. Particular consideration is given to the treatment already in place at plants within the data base.

The factors considered in identifying BPT include the total cost of applying the technology in relation to the effluent reduction benefits from such application, the age of equipment and facilities involved, the manufacturing processes employed, nonwater quality environmental impacts (including energy requirements), and other factors the Administrator considers appropriate. In general, the BPT level represents the average of the best existing performances of plants of various ages, sizes, processes, or other common characteristics. Where existing performance is uniformly inadequate, BPT may be transferred from a different subcategory or category. Limitations based on transfer of technology are supported by a rationale concluding that the technology is, indeed, transferable, and a reasonable prediction that it will be capable of achieving the prescribed effluent limits. See Tanner's Council of America v. Train, 540 F.2d 1188 (4th Cir. 1976). BPT focuses on end-of-pipe treatment rather than process changes or internal controls, except where such practices are common industry practice.

TECHNICAL APPROACH TO BPT

The Agency studied the aluminum forming category to identify the manufacturing processes used and wastewaters generated during aluminum forming. Information was collected from industry using data collection portfolios, and wastewaters from specific plants were sampled and analyzed. The Agency used these data to subcategorize the operations and determine what constitutes an appropriate BPT. The factors which were considered in establishing subcategories are discussed fully in Section IV. Nonwater quality impacts and energy requirements are considered in Section VIII.

The category has been subcategorized, for the purpose of regulation, on the basis of forming operations. On examining each of these forming operations, several additional or subsidiary processes were identified. To organize the principal forming

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process and subsidiary processes into a workable matrix for the purpose of regulation, the primary forming process and subsidiary operations usually associated with it at plants throughout the industry have been grouped together in what is known as a core. Additional subsidiary processes which may or may not be present at a facility with a given core are called ancillary operations. The basis of regulation at any facility is the set of core operations plus those ancillary operations actually found at the specific facility.

In making technical assessments of data, reviewing manufacturing processes, and evaluating wastewater treatment technology options, both indirect and direct dischargers have been considered as a single group. An examination of plants and processes did not indicate any process differences based on the type of discharge, whether it be direct or indirect. Hence, BPT is described in substantial detail for direct discharge subcategories, even though there may be no direct discharge plants in that subcategory.

Wastewater produced by the deformation operations contains significant concentrations of oil and grease, suspended solids, toxic metals, and aluminum. Surface cleaning produces a rinse water in which significant concentrations of oil and grease, suspended solids, toxic metals, and aluminum are found. The other surface treatment wastewaters have similar characteristics. Wastewater from anodizing and conversion coating, which are considered as cleaning or etching operations, also may contain chromium and cyanide. Contact cooling water is associated with some methods of casting and heat treatment and contains significant concentrations of oil and grease, suspended solids, toxic metals, aluminum, and cyanide.

BPT for the aluminum forming category is based upon common treatment of combined streams within each subcategory. Sixty-five percent of the aluminum forming plants with treatment combine waste streams in a common treatment system. The BPT treatment is similar throughout the category to the extent that oil and grease, suspended solids, and metals removal are required within each subcategory. The general treatment scheme for BPT is to apply oil skimming technology to remove oil and grease, followed or combined with lime and settle technology to remove metals and solids from the combined wastewaters. Separate preliminary treatment steps for chromium reduction, emulsion breaking, and cyanide removal are utilized when required. The BPT effluent concentrations are based on the performance of chemical precipitation and sedimentation (lime and settle) when applied to a broad range of metal-bearing wastewaters. The basis for lime and settle performance is set forth in substantial detail in Section VII. The BPT treatment train varies somewhat between subcategories to take into account treatment of hexavalent chromium, cyanide, and emulsified oils.

For each of the subcategories, a specific approach was followed for the development of BPT mass limitations. To account for production and flow variability from plant to plant, a unit of production or production normalizing parameter (PNP) was determined for each waste stream which could then be related to the flow from the process to determine a production normalized flow. Selection of the PNP for each process element is discussed in Section IV. Each process within the subcategory was then analyzed to determine (1) whether or not operations included generated wastewater, (2) specific flow rates generated, and (3) specific production normalized flows for each process. This analysis is discussed in general in Section V and summarized for the core operations in each subcategory and for the ancillary operations.

Whenever possible, the Agency establishes wastewater limitations in terms of mass rather than concentration. The production normalized wastewater flow (l/kkg or gal/ton) is a link between the production operations and the effluent limitations. The pollutant discharge attributable to each operation can be calculated from the normalized flow and effluent concentration achievable by the treatment technology.

Normalized flows were analyzed to determine which flow was to be used as part of the basis for BPT mass limitations. The selected flow (sometimes referred to as a BPT regulatory flow or BPT flow) reflects the water use controls which are common practices within the industry. The BPT normalized flow is based on the average of all applicable data. Plants with existing flows above the average may have to implement some method of flow reduction to achieve the BPT normalized flow and thus the BPT limitations. In most cases, this will involve improving housekeeping practices, better maintenance to limit water leakage, or reducing excess flow by turning down a flow valve. Except for the case of direct chill casting which requires water recycle, it is not believed that these modifications would incur any costs for the plants.

The BPT model treatment technology assumes that all wastewaters generated within a subcategory were combined for treatment in a single or common treatment system for that subcategory, even though flow and sometimes pollutant characteristics of process wastewater streams varied within the subcategory. A disadvantage of common treatment is that some loss in pollutant removal effectiveness will result where waste streams containing specific pollutants at treatable levels are combined with other streams in which these same pollutants are absent or present at very low concentrations. Under these circumstances a plant may prefer to segregate these waste streams and bypass treatment. Since treatment systems considered under BPT are primarily for metals, oil and grease, and suspended solids removal, and many existing plants usually had one common treatment system in place, a common treatment system for each subcategory is reasonable in terms of cost and effectiveness. Both treatment in place at aluminum forming plants and treatment in other categories having similar wastewaters were evaluated.

The overall effectiveness of end-of-pipe treatment for the removal of wastewater pollutants is improved by the application of water flow controls within the process to limit the volume of wastewater requiring treatment. The controls or in-process technologies recommended under BPT include only those measures which are commonly practiced within the category or subcategory and which reduce flows to meet the production normalized flow for each operation.

For the development of effluent limitations, mass loadings were calculated for each operation within each subcategory. This calculation was made on a process-by-process basis, primarily because plants in this category may perform one or more of the ancillary operations in conjunction with the core operations present. The mass loadings (milligrams of pollutant per metric ton of production unit - mg/kkg) were calculated by multiplying the BPT normalized flow (l/kkg) by the concentration achievable using the BPT model treatment system (mg/l) for each pollutant parameter to be regulated under BPT.

Regulated Pollutant Parameters

Pollutant parameters are selected for regulation in the aluminum forming subcategories because of their frequent presence at treatable concentrations in raw wastewaters. Total suspended solids, oil and grease, pH, chromium, zinc, aluminum, and cyanide have been selected for regulation in each subcategory. Treatment of wastewater from all subcategories is presumed for BPT and therefore it is necessary to regulate (provide a discharge allowance) for all regulated pollutants in each subcategory wastewater discharge.

Total suspended solids, in addition to being present at high concentrations in raw wastewater from aluminum forming operations, is an important control parameter for metals removal in chemical precipitation and settling treatment systems. The metals are precipitated as insoluble metal hydroxides, and effective solids removal is required in order to ensure reduced levels of toxic metals in the treatment system effluent. Total suspended solids are also regulated as a conventional pollutant to be removed from the wastewater prior to discharge.

Oil and grease is regulated under BPT since a number of aluminum forming operations (i.e., rolling with emulsions, roll grinding, continuous rod casting, and drawing with emulsions) generate emulsified wastewater streams which may be discharged. As seen in Section V, several waste streams have high concentrations of oil and grease. As will be discussed in detail in Section X, the organic pollutants considered for regulation in Section VI are soluble in the oil and grease fraction and are found associated with the concentrated oily wastes. Data across oil and grease treatment at sampled aluminum forming plants show that effectively removing the oil also removes 97 percent of the toxic organics (see Table X-21, p. 1106).

The importance of pH control is documented in Section VII (p. 701), and its importance in metals removal technology cannot be over emphasized. Even small excursions from the optimum pH level can result in less than optimum functioning of the system and inability to achieve specified results. The optimum operating level for most metals is usually found to be pH 8.8 to 9.3; when aluminum is also being removed, the optimum pH may be as low as 7.5 to 8.0. To allow a reasonable operating margin and to preclude the need for final pH adjustment, the effluent pH is specified to be within the range of 7.0 to 10.

Total chromium is regulated since it includes both the hexavalent and trivalent forms of chromium. Only the trivalent form is removed by the lime and settle technology. Therefore, the hexavalent form must be reduced in order to meet the limitation on total chromium in each subcategory. Chromium may be found at high levels in wastewaters from anodizing and conversion coating operations.

Zinc has been selected for regulation under BPT since it and chromium are the predominant toxic metals present in aluminum forming wastewaters. The Agency believes that when these parameters are controlled with the application of chemical precipitation and sedimentation, control of the other toxic metals is assured.

Aluminum has been selected for regulation under BPT since it is found at high concentrations in process wastewater streams from aluminum forming facilities and since it is the metal being processed, it is found in all aluminum forming process wastewaters.

Cyanide is being regulated because it was found in treatable concentrations in two solution heat treatment contact cooling water streams, one associated with a forging operation and the other a drawing operation. Sampling data after proposal indicate that cyanide was also present in one extrusion press heat treatment contact cooling water stream. Data indicate that cyanide is sometimes used as a corrosion inhibitor in the heat treatment operations. Since such corrosion inhibitors are not unique to these three plants, cyanide is selected for regulation. However, representatives of the industry have indicated that other process chemicals can be used to replace cyanide in these operations. Therefore, the most effective means for a plant to control cyanide may be for that plant to merely avoid the use of cyanide. A special monitoring provision for cyanide which allows for the owner or operator of a plant to forego periodic analysis for cyanide if certain conditions are met is included in this regulation.

The wastewaters generated during coil coating of aluminum are relatively similar to the wastewaters generated in aluminum forming in that both wastewaters contain oil and grease, suspended solids, toxic metals, aluminum, and sometimes cyanide. Concentrations of pollutants may vary somewhat. For instance, toxic metals and aluminum concentrations tend to be slightly higher in coil coating wastewaters; however, in terms of treatability, the characteristics of the wastewaters from aluminum coil coating and aluminum forming are essentially similar, and the same treatment should be equally effective when properly applied to either. Eighteen aluminum forming plants reported that they also do aluminum coil coating. Aluminum coil coating is a subcategory of the coil coating point source category. To simplify compliance with two regulations at these 18 plants, mass limitations have been established for both categories based on the application of the same treatment. Permissible discharge would be calculated by simply adding the masses that may be discharged for each category. In addition, the same pollutants are limited for both aluminum coil coating and aluminum forming, thus making it easier for plants to co-treat wastewaters from these processes.

The Agency based the proposed limits for the pollutant aluminum on data from one aluminum forming plant and one aluminum coil coating plant. Since proposal the Agency sampled four additional aluminum forming plants that treated wastewaters through lime and settle treatment. Aluminum concentration data from two of these plants were incorporated with the proposed data and the treatment effectiveness concentrations for aluminum were revised. The Agency did not use data from the other aluminum forming plants sampled since proposal because they were improperly operating their treatment systems. One plant had an effluent TSS concentration coming out of the clarifier of greater than 50 mg/l and an effluent pH above 10.0. The effluent pH of the second plant was below 7.0.

ROLLING WITH NEAT OILS SUBCATEGORY

Production Operations and Discharge Flows

The primary operation in this subcategory is rolling aluminum in a rolling mill using neat oil as a lubricant. Other ancillary production operations in this subcategory include roll grinding, annealing, stationary casting, homogenizing, artificial aging, degreasing, sawing, continuous sheet casting, solution heat treatment, and cleaning or etching. These unit operations were listed in Section IV (p. 151), along with the waste streams generated by these operations and the production normalizing parameters. Table IX-1 lists these production operations, separating them into core and ancillary operations, and identifies the production normalized wastewater flows generated from each. The core allowance for the Rolling with Neat Oils Subcategory without an annealing furnace scrubber is 55.31 l/kkg (13.27 gal/ton). This one allowance represents the sum of the individual allowances for the core waste streams which have a discharge allowance. These streams are roll grinding spent emulsion, sawing spent lubricant and miscellaneous nondescript wastewater sources. The core allowance for the Rolling with Neat Oils Subcategory with an annealing scrubber is 81.66 l/kkg (19.60 gal/ton). This one allowance represents the sum of the individual allowances for the core waste streams listed above plus the wastewater discharge allowance for the annealing scrubber liquor. The following paragraphs discuss these operations and wastewater discharge allowances.

Core Operations

Rolling with Neat Oils. The mineral oil (kerosene) based lubricants used in neat oil rolling are recycled with sediment removal or filtration. After extended use, the rolling oils are periodically disposed of by reclamation or incineration. None of the 50 plants rolling aluminum with neat oils reported any discharge of these oils to surface waters or publicly owned treatment works (POTW). For this reason, the production operation has been assigned a zero wastewater discharge allowance.

Roll Grinding. Nine facilities that perform emulsion roll grinding were contacted; one did not supply enough information to characterize the water use or discharge, and two achieved zero discharge through complete recycle of the roll grinding emulsions. The remaining six plants provided information about either their water use or wastewater generation related to roll grinding (see Table V-7 p. 210). The BPT discharge flow for this stream is 5.50 l/kkg (2.2 gal/ton) of aluminum rolled, based on the mean normalized flow of the five plants which reported discharge of this stream.

Annealing. As discussed in Section III (p. 110), the annealing operation does not use process water. The annealing operation has been included in the core of all six subcategories, because it is not specifically associated with any of the major forming processes (rolling, extruding, forging, drawing), it is a dry operation and it can be found at plants throughout the category. One of the plants surveyed in this study anneals aluminum which is rolled with neat oils and derives the inert gas atmosphere used in its annealing process from furnace off gases. Because of the sulfur content of furnace fuels, the off gases require cleaning with wet scrubbers to remove contaminants. The scrubber used involves a large flow of water with more than 99 percent recycle of the normalized flow and less than 1 percent blowdown. The blowdown at this plant is 26.35 l/kkg (6.320 gal/ton). Another plant visited by the Agency uses an electrostatic precipitator on their annealing furnace. No flow data were available from this plant; however, it does generate a wastewater discharge.

Because particulate removal is necessary to the operation of the annealing furnace, an allowance has been included as part of the core of the Rolling with Neat Oils Subcategory. Other plants purchase cleaned gases or burn natural gas to provide an inert atmosphere. These plants do not need any air pollution control devices, therefore, the Agency has established two core limitations for the Rolling with Neat Oils Subcategory. Because most plants do not have an annealing scrubber liquor flow, separate allowances will be established for core waste streams without an annealing furnace scrubber and for core waste streams with an annealing furnace scrubber.

The annealing scrubber liquor allowance has been included in the core to maintain consistency in the regulation. For the other five subcategories, all annealing operations are performed using no process water and annealing has been assigned a zero pollutant allowance and is included in the core.

Stationary Casting. In stationary casting, molten aluminum is poured into specific shapes for rolling and further processing. It was observed that in 14 plants that reported this operation, stationary casting is performed without the discharge of any contact cooling water. Frequently, the aluminum is allowed to air cool and solidify. Often, the stationary molds are internally cooled with noncontact cooling water. In some plants, a small amount of water or mist is applied to the top of the stationary cast aluminum to promote more rapid solidification and allow earlier handling. In most cases, contact cooling water is either collected and recycled or it evaporates. Therefore, stationary casting is included in the core of the Rolling with Neat Oils Subcategory with no wastewater discharge allowance.

Homogenizing. Homogenizing is a type of heat treatment to control physical properties of the aluminum which frequently follows casting. Two plants indicate the use of water to aid final cooling after homogenizing; however, the water flow is very small. Twenty-seven other plants performing homogenizing reported no water use in this process. Therefore, no flow allowance has been provided for this operation. Since homogenizing is a zero discharge process, it is included in the core of the Rolling with Neat Oils Subcategory with no wastewater discharge allowance.

Artificial Aging. Artificial aging is a type of heat treatment to control physical properties of the aluminum. Because the process is a dry process, it is included in the core of the Rolling with Neat Oils Subcategory with no wastewater discharge allowance.

Degreasing. Thirty-four plants with solvent degreasing operations were surveyed, and only two indicated having process wastewater streams associated with the operation. One facility uses a water rinse after solvent degreasing, while the second discharges solvent recovery sludge to the facility's oil treatment system. Because 32 plants practice solvent degreasing without wastewater discharge, the Agency believes zero discharge of wastewater is an appropriate discharge allowance.

Spent degreasing solvents which are used in the aluminum forming category have been listed as hazardous wastes from nonspecific sources (45 FR 33123). If degreasing spent solvents are combined with any other aluminum forming wastewaters and discharged, then that discharge could be a hazardous waste and may become subject to the requirements of the Resource Conservation and Recovery Act (RCRA) (see 45 FR 33066). Thus, this waste should not be combined with wastewater treatment sludges because disposal of the combined discharge would be difficult and costly to achieve under the RCRA requirements.

Sawing. Although the sawing operation is assumed to be present at all facilities, only 12 plants specifically stated that they perform this operation. Some of these plants reported using a neat oil for lubrication, although emulsified lubricants are also used. One plant reported no oils disposal due to evaporation and carryover. Six other plants supplied wastewater discharge flow data which were used to calculate a mean value of 4.807 l/kkg (1.153 gal/ton) of aluminum rolled for the BPT discharge flow for this stream (see Table V-29 p. 260).

Miscellaneous Nondescript Wastewater Sources. A flow allowance of 45.0 l/kkg (10.8 gal/ton) of aluminum processed through the core operations is being established for miscellaneous nondescript wastewater streams such as ultrasonic testing, maintenance and clean-up, roll grinding of caster rolls, and seal and dye baths when not followed by a rinse. These miscellaneous wastewaters were observed during site visits and sampling visits at some facilities and are characterized by intermittent, low flow discharges. The flow allowance was calculated by averaging three flow values of this waste stream submitted by industry; two are ultrasonic testing flows and one is a maintenance and clean-up flow (see Table V-79 p. 460).

Ancillary Operations

Continuous Sheet Casting. Contact cooling water is not normally used in continuous casting of aluminum sheet; however, lubricants may be required in the associated smoothing roller. Fifteen plants with continuous sheet or strip casting were surveyed; seven reported no lubricants used, two claimed to achieve 100 percent recycle of lubricants without disposal, three indicated periodic disposal of recycled material was necessary, and three provided insufficient data. For the three plants reporting disposal of the lubricant, the mean normalized discharge flow is 1.964 l/kkg (0.471 gal/ton) of aluminum cast; this is the BPT wastewater discharge flow for the stream (see Table V-71 p. 429). When a plant performs roll grinding of these caster rolls on site, the discharge from that operation is covered by the miscellaneous nondescript flow allowance.

Solution Heat Treatment. Tables V-39 through V-49 (pp. 285-317) contain data taken from dcp's on the wastewater flow from solution and press heat treatment quenching for all the subcategories. It has been determined that the amount of water used does not vary significantly between subcategories; therefore, the data are grouped, and the mean normalized flow of 7,705 l/kkg (1,848 gal/ton) of aluminum quenched following solution heat treatment is the BPT discharge flow.

Of the 89 heat treatment quenching processes surveyed, 52 report no recycle of quench water, 25 recycle varying amounts of quench water, and 12 claimed no discharge of this wastewater stream by practicing total recycle. It is possible that the plants reporting no discharge of cooling water inadvertently failed to mention necessary periodic blowdown of the cooling tower to prevent solids accumulation. Since no technology for avoiding the buildup of solids in completely recycled cooling water is known to be applied in this category, only nonzero wastewater values were used as a data base for selecting the BPT discharge flow.

This includes plants that vary from no recycle to 99 percent recycle.

Cleaning or Etching. Cleaning or etching functions are performed in approximately 20 percent of the rolling with neat oils facilities. Wastewaters are or may be produced from three segments of cleaning or etching operations. These are from process baths, which are usually batch dumped; product rinsing; and air pollution control scrubbing.

All of the subcategories include a wide range of cleaning or etching operations including caustic baths and rinses, acid baths and rinses, detergent baths and rinses, and conversion coating and anodizing baths and rinses. The Agency has concluded that these processes are similar in that a workpiece is placed in a bath for the time necessary to obtain the desired result, removed and rinsed to remove excess solution and undesired dragout from the bath. In many cases, a workpiece is sequentially exposed to several etch line baths and rinses. The generation of wastewater from these operations is generally similar and any known differences have been taken into account by inclusion of all wastewater generated by the entire cleaning and etching line. Separate consideration of each and every possible cleaning and etching operation would severely increase the complexity of the regulation. Therefore, the Agency believes that it is appropriate to combine these operations into a single allowance.

The ancillary operation of cleaning or etching includes all surface treatment operations, including chemical or electrochemical anodizing and conversion coating when performed as an integral part of the aluminum forming process. For the purposes of this regulation, surface treatment of aluminum is considered to be an integral part of aluminum forming whenever it is performed at the same plant site where aluminum is formed. A cleaning or etching operation is defined as a cleaning or etching bath followed by a rinse. Multiple baths are considered multiple cleaning or etching operations with a separate limitation for each bath which is followed by a rinse. Multiple rinses following a single bath will be regulated by a single limitation.

Process Baths. Of the 34 plants reporting cleaning or etching operations, three indicated that the chemical baths used for cleaning or etching of formed aluminum products are discharged continuously into the wastewater from the rinsing operation; 12 plants indicated that the process baths are discharged periodically in a batch discharge mode; and 14 operate indefinitely without discharge by adding make-up chemicals and water to offset the dragout loss from processing. The remaining five plants supplied no information about discharges from cleaning or etching baths.

While it is assumed that the majority of plants dispose of the chemical bath by a solid waste contractor or eliminate the bath in other ways, some plants do in fact treat and discharge their process baths. For BPT, it is assumed that the process baths will be periodically discharged to treatment by bleeding them over a long period of time to achieve an equal distribution of flow. Based on 16 flow values from the 12 plants which reported a wastewater discharge flow, a mean normalized discharge flow of 179 l/kkg (43 gal/ton) of aluminum etched is the flow allowance for this stream. A summary of this data is presented in Table V-52 (p. 326).

Product Rinses. A summary of water use and wastewater discharge from product rinses is presented in Table V-55 (p. 349). This shows that some plants discharge very small volumes of wastewater even though their water use is substantial. These data have been restructured in Table IX-2 to more clearly show the rinse line characteristic of this data. All plants with cleaning or etching operations reported discharging their rinses. For the purpose of establishing BPT limitations, all 44 data points were averaged on a per-rinse-operation basis. The mean normalized wastewater flow per rinsing operation is 13,912 l/kkg (3,339 gal/ton) of aluminum rinsed, which is the BPT discharge flow for this stream.

Air Pollution Control Scrubbers. Seven plants surveyed reported using wet air pollution control devices on cleaning or etching operations. As presented in Table V-58 (p. 391), data were available to calculate normalized wastewater flows from four of the seven plants, and the mean wastewater flow is 15,900 l/kkg (3,816 gal/ton) of aluminum cleaned or etched.

Pollutants

The pollutants considered for regulation under BPT are listed in Section VI, along with an explanation of why they have been selected. The pollutants selected for regulation under BPT are chromium (total), cyanide (total), zinc, aluminum, oil and grease, TSS, and pH. The toxic organic pollutants, cadmium, copper, lead, nickel, and selenium, listed in Section VI are not specifically regulated under BPT for the reasons explained in Section X (p. 1058).

Table IX-3 lists the pollutants considered for regulation associated with each wastewater stream in the Rolling with Neat Oils Subcategory and the corresponding maximum and minimum concentrations detected for each pollutant.

Treatment Train

The BPT model treatment train for the Rolling with Neat Oils Subcategory consists of preliminary treatment when necessary, specifically emulsion breaking and skimming, hexavalent chromium reduction, and cyanide precipitation. The effluent from preliminary treatment is combined with other wastewaters for common treatment by skimming and lime and settle. Sawing spent lubricants, roll grinding spent emulsions, and casting spent lubricants require emulsion breaking and skimming, and may require hexavalent chromium reduction prior to combined treatment by skimming and lime and settle. Solution heat treatment contact cooling water may require cyanide precipitation, while cleaning or etching wastewaters may require chromium reduction in addition to cyanide precipitation. Following the preliminary treatment, these wastewaters are then treated by oil skimming and lime and settle. This treatment train is presented in Figure IX-1.

Cyanide precipitation is practiced on coil coating wastewaters at six plants, two of which have both aluminum forming and aluminum coil coating operations. Although it is not currently practiced at plants which perform only aluminum forming operations, the same cyanide and metallocyanide complexes would be present in these wastewaters as in the coil coating wastewaters. These wastewaters include heat treatment contact cooling water streams and cleaning or etching (conversion coating) wastewater streams which are subject to the aluminum forming regulation. The cyanide precipitation technology demonstrated on coil coating wastewater would be applicable to aluminum forming wastewaters.

The process, which is described in detail in Section VII (p. 706), involves the addition of ferrous sulfate heptahydrate and pH adjustment chemicals to the raw wastewater in a rapid mix tank. The resulting sludge is settled in a clarifier or other settling device, and the treated water is routed to downstream processing. Advantages of the cyanide precipitation process over the conventional oxidation route are reported to include better removal of complexed cyanide and significant cost savings.

Technology transfer of cyanide precipitation is justified because existing treatment in the aluminum forming category is uniformly inadequate since no plants are currently treating wastewaters from aluminum forming with any cyanide removal technology. In addition, as discussed previously in this section, the wastewaters generated during coil coating of aluminum are similar to the wastewaters generated in aluminum forming.

Transfer of cyanide precipitation technology from the coil coating category to the aluminum forming category is appropriate because the cyanide is derived from processing aluminum in both categories and the raw wastewater matrices are homogeneous. The homogeneity of these raw wastewaters has been tested during the development of the combined metals data base and their homogeneity confirmed. Full details of this examination are presented in the administrative record of this rulemaking.

Data available to the Agency, discussed in Section VII (p. 706) and presented in Table VII-8 (p. 795), indicate that the application of cyanide precipitation technology can achieve the cyanide treatment effectiveness concentration presented in Table VII-20 (p. 807), even over a wide range of cyanide concentration in the raw waste.

Effluent Limitations

Table VII-20 (p. 807), presents the treatment effectiveness corresponding to the BPT model treatment train for pollutant parameters considered in the Rolling with Neat Oils Subcategory. Effluent concentrations (one day maximum and ten day average values) are multiplied by the normalized discharge flows summarized in Table IX-1 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table IX-4.

Benefits

In establishing BPT, EPA must consider the cost of treatment and control in relation to the effluent reduction benefits. BPT costs and benefits are tabulated along with BAT costs and benefits in Section X. As shown in Table X-3 (p. 1076), the application of BPT to the total Rolling With Neat Oils Subcategory will remove approximately 1,725,611.3 kg/yr (3.796 million lbs/yr) of pollutants. As shown in Table X-1, (p. 1074), the corresponding capital and annual costs (1982 dollars) for this removal are $13.5 million and $10.7 million per year, respectively. As shown in Table X-9 (p. 1089), the application of BPT to direct dischargers only, will remove approximately 1,448,032.2 kg/yr (3.186 million lbs/yr) of pollutants. As shown in Table X-2 (p. 1075), the corresponding capital and annual costs (1982 dollars) for this removal are $9.55 million and $8.20 million per year, respectively. The Agency concludes that these pollutant removals justify the costs incurred by plants in the Rolling with Neat Oils Subcategory.

ROLLING WITH EMULSIONS SUBCATEGORY

Production Operations and Discharge Flows

The primary operation in this subcategory is rolling aluminum in a rolling mill using emulsified oil as a lubricant. Other subsidiary production operations in the subcategory include roll grinding, annealing, stationary casting, homogenizing, artificial aging, degreasing, sawing, direct chill casting, solution heat treatment, and cleaning or etching. These unit operations were tabulated with the waste streams generated and production normalized parameters in Section IV (p. 154). Table IX-5 lists these production operations, separating them into core and ancillary operations, and identifies the production normalized wastewater flows generated from each. The core allowance for the Rolling with Emulsions Subcategory is 129.8 l/kkg (31.2 gal/ton). This one allowance represents the sum of the individual allowances for the core waste streams which have a discharge allowance. These streams are rolling with emulsions spent emulsions, roll grinding spent emulsions, sawing spent lubricant and miscellaneous nondescript wastewater sources. The following paragraphs discuss these operations and wastewater discharge flows.

Core Operations

Rolling with Emulsions. The oil in water emulsion used as a lubricant in many rolling operations is frequently discharged to surface waters or a POTW. All of the 29 plants in this subcategory recycle their emulsions. Five plants report recycle with a continuous bleed, and the remaining plants dump their emulsions periodically.

In selecting the BPT discharge flow appropriate for spent rolling emulsions, a number of variables were analyzed for their effect on the wastewater generated:

- Degree of recycle.
- Degree of reduction.
- Product type.
- Annual production.

The data presented in Table V-4 (p. 196) show the production normalized volume of spent lubricant which is discharged by the plants in the Rolling with Emulsions Subcategory. The median value is extremely small in comparison to the discharge flows from the plants with higher production normalized discharges. Therefore, the BPT discharge flow is based on the normalized mean of all available data for spent rolling emulsions and is 74.51 l/kkg (17.87 gal/ton).

Recycle rates at plants with a bleed discharge varied from 85 to 99 percent. The remaining plants discharge periodically, implying recycle, but in most cases percent recycle values cannot be assigned. Neither the degree of recycle nor the mode of discharge significantly affected the normalized wastewater flow distributions.

Although most of the cold rolling operations surveyed use neat oil lubricants, a few plants indicated the use of emulsions for cold rolling operations. Analysis of the data showed that cold rolling with emulsions results in discharge values comparable to those associated with hot rolling processes. Normalized discharge flows vary from plant to plant; especially high values were noted at one plant for both their cold rolling and hot rolling operations. Since the process itself may be considered to be confidential, a thorough discussion of this data is precluded. The data which are available suggest that the reduction of plate to sheet or foil by emulsion cold rolling results in emulsion discharge comparable to the amount discharged by the hot rolling of ingot to plate. Discharge rates from these two operations are compared below for the same plants:

Cold Roll Discharge		Cold Rolled Product	Hot Roll Discharge	
l/kkg	gpt		l/kkg	gpt
183.5	44	Sheet	304.4	73
7.26	1.74	Sheet and Foil	--	--
0.584	0.14	Sheet and Foil	0.392	0.094
0.668	0.16	Sheet and Foil	89.4	21.44

Therefore, the Agency is not distinguishing between cold rolling emulsions and hot rolling emulsions to establish the BPT normalized discharge flow.

Roll Grinding. Roll grinding is associated with virtually all rolling operations and is, therefore, included in the core of the Rolling with Emulsions Subcategory. This operation was described previously in the discussion of rolling with neat oils. Roll grinding operations and wastewater discharges are similar throughout the industry; therefore, the same BPT technology and normalized flow is applied to roll grinding in both rolling subcategories.

Annealing. Annealing is a type of heat treatment which is often associated with aluminum forming operations. The basic operation is dry, although water can be used to clean furnace off gases. In the Rolling with Emulsions Subcategory, no annealing operation uses water for scrubbing; therefore, this stream is assigned a zero discharge allowance and is included in the core for regulatory convenience.

Stationary Casting. Stationary casting is similar throughout the aluminum forming category, and no discharge of process wastewater was ever reported. Therefore, stationary casting is included in the core of the Rolling with Emulsions Subcategory with no wastewater discharge allowance. For a more detailed discussion, refer to the Rolling with Neat Oils Subcategory description.

Homogenizing. Homogenizing is a heat treatment process that frequently follows casting. For the reasons discussed previously, it has been assigned a zero discharge allowance and is, therefore, included as a core stream in this subcategory. Homogenization operations are similar throughout the industry. For a more detailed description of the operation, refer to the Rolling with Neat Oils Subcategory discussion.

Artificial Aging. Artificial aging, a common heat treatment, does not generate process wastewater. Therefore, artificial aging is included in the core of the Rolling with Emulsions Subcategory as a regulatory convenience.

Degreasing. All plants surveyed in this subcategory reporting degreasing operations indicated that no wastewater is discharged; therefore, this stream has no wastewater discharge allowance. Degreasing operations are similar in all subcategories of the industry. For a more detailed description of the operation, refer to the Rolling with Neat Oils section.

Sawing. Sawing is assumed to be associated with all rolling operations and has been included in the core of the Rolling with Emulsions Subcategory. On the basis of available data, sawing operations and lubricant discharge practices appear to be similar throughout the aluminum forming category. For a description of the normalized discharge flow associated with sawing, refer to the Rolling with Neat Oils Subcategory description.

Miscellaneous Nondescript Wastewater Sources. An allowance for miscellaneous wastewater sources is included in the core of each subcategory. A description of this allowance and the BPT discharge flow designated for these miscellaneous wastewater sources was presented in the discussion of the Rolling with Neat Oils Subcategory.

Ancillary Operations

Direct Chill Casting. At 20 of the 29 plants surveyed in the Rolling with Emulsions Subcategory, aluminum is cast by the direct chill method before it is rolled. As a regulatory convenience, direct chill casting has been designated as an ancillary operation associated with this subcategory. In addition, primary aluminum reduction plants and some secondary aluminum plants covered by the nonferrous metals category use direct chill casting. The direct chill casting process used in the aluminum forming and primary aluminum plants is identical. Direct chill casting has been included in the aluminum forming category as a regulatory convenience. Therefore, it is appropriate to consider wastewater flow data from all the plants in these categories using direct chill casting when establishing BPT effluent limitations.

In all, 61 aluminum forming plants, 25 primary aluminum plants, and five secondary aluminum plants have direct chill casting operations. The distribution of wastewater rates associated with direct chill casting is presented in Tables V-64 and V-65 (pp. 404 and 406, respectively). Recycle of the contact cooling water is practiced at 30 aluminum forming, nine primary aluminum, and all five secondary aluminum plants. Of these, 13 plants indicated that total recycle of this stream made it possible to avoid any discharge of wastewater; however, the majority of the plants discharge a bleed stream. The BPT discharge flow for this operation is based on the average of the best, which is the average normalized discharge flow of the 23 plants with 90 percent recycle or greater. That flow is 1,329 l/kkg (319 gal/ton) of aluminum cast by direct chill methods.

Solution Heat Treatment. Solution heat treatment is practiced by plants in all of the aluminum forming subcategories. Solution heat treatment involves water quenching of the hot metal and results in substantial water use requirements. Due to the similarity in water use requirements among the various subcategories, the water use data were combined and analyzed as a single data set. The solution heat treatment operation and normalized discharge flow for the associated wastewater streams are described in conjunction with the Rolling with Neat Oils Subcategory.

Cleaning or Etching. Cleaning or etching operations were described in detail in the Rolling with Neat Oils Subcategory description. Wastewater streams associated with these operations may include chemical baths, rinse water, and air pollution control scrubbers. Refer to Rolling with Neat Oils section for a description of these wastewater streams and discharge flows.

Pollutants

The pollutants considered for regulation under BPT are listed in Section VI, along with an explanation of why they have been selected. The pollutants selected for regulation under BPT are chromium (total), cyanide, (total), zinc, aluminum, oil and grease, TSS, and pH. The toxic organic pollutants, cadmium, copper, lead, nickel, and selenium, listed in Section VI are not specifically regulated under BPT for the reasons explained in Section X (p. 1058).

Table IX-6 lists the pollutants considered for regulation associated with each wastewater stream in the Rolling with Emulsions Subcategory and the corresponding maximum and minimum concentrations detected for each pollutant.

Treatment Train

The BPT model treatment train for the Rolling with Emulsions Subcategory consists of preliminary treatment when necessary, specifically emulsion breaking and skimming, hexavalent chromium reduction, and cyanide precipitation. The effluent from preliminary treatment is combined with other wastewaters for common treatment by oil skimming and lime and settle. Sawing spent lubricant, roll grinding spent emulsions, and casting spent lubricants require emulsion breaking and skimming, and may require hexavalent chromium reduction prior to combined treatment by skimming and lime and settle. Solution heat treatment contact cooling water may require cyanide precipitation, while cleaning or etching wastewaters may require chromium reduction in addition to cyanide precipitation. Following the preliminary treatment, these wastewaters are then treated by skimming and lime and settle. This treatment train is presented in Figure IX-2.

Effluent Limitations

Table VII-20 (p. 807) presents the treatment effectiveness corresponding to the BPT model treatment train for pollutant parameters considered in the Rolling with Emulsions Subcategory. Effluent concentrations (one day maximum and ten day average values) are multiplied by the normalized discharge flows summarized in Table IX-5 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table IX-7.

Benefits

In establishing BPT, EPA must consider the cost of treatment and control in relation to the effluent reduction benefits. BPT costs and benefits are tabulated along with BAT costs and benefits in Section X. As shown in Table X-4 (p. 1078), the application of BPT to the total Rolling with Emulsions Subcategory will remove approximately 12,300,000 kg/yr (2.7 million lb/yr) of pollutants. As shown in Table X-1 (p. 1074), the corresponding capital and annual costs (1982 dollars) for this removal are $14.7 million and $15.2 million per year, respectively. As shown in Table X-10 (p. 1091), the application of BPT to direct dischargers only, will remove approximately 10,730,699.0 kg/yr (23.607 million lb/yr) of pollutants. As shown in Table X-2 (p. 1075), the corresponding capital and annual costs (1982 dollars) for this removal are $13.96 million and $14.48 million per year, respectively. The Agency concludes that these pollutant removals justify the costs incurred by plants in the Rolling with Emulsions Subcategory.

EXTRUSION SUBCATEGORY

Production Operations and Discharge Flows

The primary operation in this subcategory is extrusion, including die cleaning and dummy block cooling operations. Other subsidiary production operations in the subcategory include annealing, stationary casting, homogenizing, artificial aging, degreasing, sawing, direct chill casting, extrusion press hydraulic fluid leakage, solution and press heat treatment, cleaning or etching, and degassing. These unit operations were tabulated with the waste streams generated and production normalized parameters in Section IV (p. 156). Table IX-8 lists these production operations, separating them into core and ancillary operations, and identifies the production normalized wastewater flows generated from each. The core allowance for the Extrusion Subcategory is 363.82 l/kkg (87.4 gal/ton). This one allowance represents the sum of the individual allowances for the core waste streams which have a discharge allowance. These streams are extrusion die cleaning bath, rinse and scrubber liquor, sawing spent lubricant, and miscellaneous non-descript wastewater sources. The following paragraphs discuss these operations and wastewater discharge flows.

Core Operations

Extrusion Die Cleaning Bath and Rinse. The cleaning of extrusion dies by immersion in caustic baths is described in Section III (p. 101). Although most of the plants contacted discharge the caustic bath (with or without treatment) to surface waters or a POTW, the solution is hauled from at least four plants by an outside contractor. Thirteen plants reported discharge rates as shown in Table V-10 (p. 220). One plant reported no discharge of the die cleaning bath, and 27 plants did not report enough data to calculate a normalized discharge flow.

The volume of caustic required will depend on the intricacy of the die orifice, the temperature of extrusion, the lubricant used, and many other factors. Sufficient data are not available to investigate these possibilities. Furthermore, it is likely that the effect of individual plant practices (e.g., dumping prior to saturation) may mask the effect of these factors. Therefore, the mean normalized discharge flow, 12.9 l/kkg (3.096 gal/ton) of aluminum extruded, based on all 13 plants that discharge die cleaning baths, has been chosen as the basis for BPT limitations. In addition, any effect of these factors on the discharge flow is taken into account by the use of the 13 flow values collected by industry.

As discussed in Section V (Table V-11, p. 221), the wastewater flows for extrusion die cleaning rinses are available for 13 of the 37 plants known to have die cleaning operations. Of the 13 plants, one reports no discharge of die cleaning rinse water. The normalized mean of the other 12 is 25.62 l/kkg (6.145 gal/ton).

Although many factors could influence the amount of water needed for rinsing the dies, it appears that individual plant practices are the most significant factor. Frequently, the dies are simply hosed off, and the quantity of water used is not carefully controlled. It is anticipated that plants discharging volumes greater than the mean will be able to reduce the volume of water discharged by applying tighter controls on the water used to rinse the dies.

The normalized discharge flow for the BPT limitations of the combined bath and rinse streams is the summation of the two means, 12.90 l/kkg and 25.62 l/kkg, which is 38.52 l/kkg (9.245 gal/ton).

Extrusion Die Cleaning Scrubber. A wet scrubber can be used to control caustic fumes from the die cleaning bath. Although only two plants with die cleaning baths reported scrubbers, it is believed that most employ wet scrubbers. The two plants supplied enough information to calculate a normalized discharge flow. These flows were averaged to be 275.5 l/kkg (66.08 gal/ton) which will be used as the BPT wastewater discharge flow.

Two plants reported the use of wet scrubbers at the extrusion presses to remove caustic fumes. One of these scrubbers is operated only when the die cleaning process is in operation and serves to remove the caustic fumes generated by cleaning the dies. This scrubber is considered an extrusion die cleaning scrubber and will have the same flow allowance of 275.5 l/kkg.

The second scrubber operates at all times, although the die cleaning process is in operation only intermittently. This scrubber serves to remove fumes from various sources in the area as well as the die cleaning caustic fumes. This scrubber is considered an area scrubber as well as a die cleaning scrubber. Because area scrubbers are included in the miscellaneous nondescript wastewater allowance, this scrubber will receive both flow allowances: extrusion die cleaning scrubber liquor at 275.5 l/kkg and miscellaneous nondescript wastewater at 45 l/kkg.

Dummy Block Cooling. Of the 163 plants that practice extrusion, only three report discharge of a dummy block contact cooling stream. Air cooling of the dummy blocks is used for cooling by the vast majority of extrusion plants. For this reason, dummy block contact cooling has been classified as a zero pollutant discharge allowance stream.

Annealing. Annealing is a type of heat treatment which is often associated with aluminum forming operations. The basic operation is dry, although water can be used to clean furnace off gases. In the Extrusion Subcategory, no annealing operation uses water for scrubbing; therefore, this stream is assigned a zero discharge allowance and is included in the core for regulatory convenience.

Stationary Casting. Stationary casting is associated with most of the aluminum forming subcategories and is designated as a zero discharge operation. The operation is similar throughout the industry and was never found to generate a wastewater stream. Therefore, stationary casting is included in the core of the Extrusion Subcategory with no wastewater discharge allowance. For a more detailed description, refer to the discussion of stationary casting operations associated with the Rolling with Neat Oils Subcategory.

Homogenizing. Homogenizing is a heat treatment process that frequently follows casting. For the reasons discussed previously, it has been assigned a zero discharge allowance and is, therefore, included as a core stream in this subcategory. Homogenization operations are similar throughout the industry. For a more detailed description of the operation, refer to the Rolling with Neat Oils Subcategory discussion.

Artificial Aging. Artificial aging, a common heat treatment, does not generate process wastewater. Therefore, artificial aging is included in the core of the Extrusion Subcategory as a regulatory convenience.

Degreasing. All of the extrusion plants surveyed which reported having degreasing operations indicated that those operations generated no wastewater discharge; therefore, this stream has no wastewater discharge allowance. Degreasing operations are similar in all subcategories of the industry. For a more detailed description of the operation, refer to the Rolling with Neat Oils Subcategory description.

Sawing. Because sawing is associated with extrusion operations, it has been included in the core of the Extrusion Subcategory. On the basis of available data, sawing operations and lubricant discharge practices appear to be similar throughout the aluminum forming category. For a description of the normalized discharge flow associated with sawing, refer to the Rolling with Neat Oils Subcategory description.

Miscellaneous Nondescript Wastewater Sources. An allowance for miscellaneous wastewater sources is included in the core of each subcategory. A description of this allowance and the BPT discharge flow designated for these miscellaneous wastewater sources was presented in the discussion of the Rolling with Neat Oils Subcategory.

Ancillary Operations

Direct Chill Casting. At 44 of the 163 plants surveyed in the Extrusion Subcategory, aluminum is cast by the direct chill method before extrusion. In addition, rolling with emulsions plants as well as primary and secondary aluminum plants frequently use direct chill casting. See the Rolling with Emulsions Subcategory for a discussion of how the BPT discharge flow for direct chill casting was determined.

Extrusion Press Hydraulic Fluid Leakage. Extrusion press hydraulic fluids are used in extrusion presses. Neat oil hydraulic fluids are most commonly used and are not discharged. Oil-water emulsions are also used, primarily in conjunction with the processing of hard aluminum alloys and for processing very large extrusions. Five plants reported the use and wastewater discharge of oil-water emulsion hydraulic fluids as shown in Table V-75 (p. 436). Data and information collected during engineering plant visits indicate that a flow allowance for this wastewater source is necessary because emulsion hydraulic fluids tend to leak thereby generating a wastewater source. A BPT discharge flow allowance of 1,478 l/kkg (355 gal/ton) for this waste stream is based on the average of the production normalized flow data for the three plants that did not perform recycle. This flow allowance is applicable when extrusion press hydraulic fluid leakage is treated and discharged by a plant.

Solution and Press Heat Treatment. Solution heat treatment is practiced by plants in all of the aluminum forming subcategories. Solution heat treatment involves water quenching of the heated metal and results in substantial water use requirements. Press heat treatment is a water spray operation which cools the metal immediately after extrusion. Water use for all heat treatment contact cooling operations show the similarity in water use requirements among solution and press heat treatment and the various subcategories. Due to this similarity, the water use data were combined and analyzed as a single data set. The solution heat treatment operation and the normalized discharge flow for the associated wastewater stream are described in conjunction with the Rolling with Neat Oils Subcategory.

Cleaning or Etching. Wastewater streams associated with cleaning or etching operations may include chemical baths, rinse water, and air pollution control scrubbers. Refer to the Rolling with Neat Oils section for a description of these wastewater streams and the associated discharge flows.

Degassing. In remelting aluminum prior to casting or continuous casting, it is sometimes necessary to remove significant amounts of magnesium or dissolved gases through the addition of chlorine to the molten metal mass. When this is performed to remove magnesium, it is called demagging and is a common refining practice in the secondary aluminum industry. In the aluminum forming industry, chlorine or inert gases are used to remove dissolved gases in a similar operation called degassing, which does not change the metal content of the melt. The degassing processes and scrubber liquor wastewater characteristics are similar for aluminum forming and primary aluminum plants. Demagging is subject to the secondary aluminum effluent limitations, while degassing is considered part of aluminum forming when it is performed as an integral part of an aluminum forming process.

Only one aluminum forming plant employs a wet scrubber for their degassing operation, and no data are available to calculate that discharge flow. Therefore, the BPT discharge flow for degassing scrubber liquor blowdown is based on the mean normalized flow from four primary aluminum subcategory plants using degassing scrubbers and is 2,607 l/kkg (626 gal/ton) as shown in Table V-72 (p. 430).

Pollutants

The pollutants considered for regulation under BPT are listed in Section VI, along with an explanation of why they have been selected. The pollutants selected for regulation under BPT are chromium (total), cyanide (total), zinc, aluminum, oil and grease, TSS, and pH. The toxic organic pollutants, cadmium, copper, lead, nickel, and selenium, listed in Section VI are not specifically regulated under BPT for the reasons explained in Section X (p. 1058).

Table IX-9 lists the pollutants considered for regulation associated with each wastewater stream in the Extrusion Subcategory and the corresponding maximum and minimum concentrations detected for each pollutant.

Treatment Train

The BPT model treatment train for the Extrusion Subcategory consists of preliminary treatment when necessary, specifically emulsion breaking and skimming, hexavalent chromium reduction, and cyanide precipitation. The effluent from preliminary treatment is combined with other wastewaters for common treatment by skimming and lime and settle. Sawing spent lubricants require emulsion breaking and skimming and may require hexavalent chromium reduction prior to combined treatment by skimming and lime and settle. Solution and press heat treatment contact cooling water may require cyanide precipitation, while cleaning or etching and die cleaning wastewaters may require chromium reduction in addition to cyanide precipitation. Following the preliminary treatment, these wastewaters are then treated by skimming and lime and settle. This treatment train is presented in Figure IX-3.

Effluent Limitations

Table VII-21 (p. 807) presents the treatment effectiveness corresponding to the BPT model treatment train for pollutant parameters considered in the Extrusion Subcategory. Effluent concentrations (one day maximum and ten day average values) are multiplied by the normalized discharge flows summarized in Table IX-8 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table IX-10.

Benefits

In establishing BPT, EPA must consider the cost of treatment and control in relation to the effluent reduction benefits. BPT costs and benefits are tabulated along with BAT costs and benefits in Section X. As shown in Table X-5 (p. 1080), the application of BPT to the total Extrusion Subcategory will remove approximately 4,207,477.7 kg/yr (9.26 million lb/yr) of pollutants. As shown in Table X-1 (p. 1074), the corresponding capital and annual costs (1982 dollars) for this removal are $34.6 million and $25.5 million per year, respectively. As shown in Table X-11 (p. 1093), the application of BPT to direct dischargers only, will remove approximately 2,831,772.1 kg/yr (6.23 million lb/yr) of pollutants. As shown in Table X-2 (p. 1075), the corresponding capital and annual costs (1982 dollars) for this removal are $21.1 million and $13.0 million per year, respectively. The Agency concludes that these pollutant removals justify the costs incurred by plants in the Extrusion Subcategory.

FORGING SUBCATEGORY

There are no direct discharging facilities which use forging processes to form aluminum. Consequently, the Agency is excluding the Forging Subcategory from this regulation for existing direct dischargers (BPT and BAT). The discussion which follows is presented for consistency and completeness. In addition, this discussion forms the basis for pretreatment standards for the Forging Subcategory presented in Section XII.

Production Operations and Discharge Flows

The production operations that may be present at a forging plant include forging, annealing, artificial aging, degreasing, sawing, forging scrubbing, solution heat treatment, and cleaning or etching. These unit operations were tabulated with the waste streams generated and production normalizing parameters in Section IV (p. 158). Table IX-11 lists these production operations, separating them into core and ancillary operations, and identifies the production normalized wastewater flows generated from each. The core allowance for the Forging Subcategory is 49.8 l/kkg (11.95 gal/ton). This one allowance represents the sum of the individual allowances for the core waste streams which have a discharge allowance. These streams are sawing spent lubricant and miscellaneous non-descript wastewater sources. The following paragraphs discuss these operations and wastewater discharge flows.

Core Operations

Forging. As discussed in Section III (p. 102), the forging process itself does not use any process water; therefore, forging is assigned a zero discharge allowance and is included in the core for regulatory convenience.

Annealing. Annealing is a type of heat treatment which is often associated with all aluminum forming operations. The basic operation is dry, although water can be used to clean furnace off gases. In the Forging Subcategory, no annealing operation uses water for scrubbing; therefore, this stream is assigned a zero discharge allowance and is included in the core for regulatory convenience.

Artificial Aging. Artificial aging, a common heat treatment, does not generate wastewater. Therefore, artificial aging is included in the core of the Forging Subcategory as a regulatory convenience.

Degreasing. All plants reporting degreasing operations indicated that no wastewater is discharged; therefore, this stream has no wastewater discharge allowance. Degreasing operations are similar in all subcategories of the industry. For a more detailed description of the operation, refer to the Rolling with Neat Oils section.

Sawing. Because sawing can be associated with forging operations, it has been included in the core of the Forging Subcategory. On the basis of available data, sawing operations and lubricant discharge practices appear to be similar throughout the aluminum forming category. For a description of the normalized discharge flow associated with sawing, refer to the previous discussion in the Rolling with Neat Oils section.

Miscellaneous Nondescript Wastewater Sources. An allowance for miscellaneous wastewater sources is included in the core of each subcategory. A description of this allowance and the BPT discharge flow designated for these miscellaneous wastwater sources was presented previously in the discussion of the Rolling with Neat Oils Subcategory.

Ancillary Operations

Forging Scrubbing. Particulates and smoke are generated from the partial combustion of oil-based lubricants used in the forging process. Of the 16 forging plants surveyed, four indicated that wet scrubbers are used to control the emissions associated with this process. Three of these plants reported discharge rates for the scrubber blowdown. Three indicated that dry air pollution control devices are employed. The mean normalized discharge flow from three wet scrubbers, 1,547 l/kkg (371.0 gal/ton), has been selected as the BPT discharge flow for the forging scrubber liquor stream.

Solution Heat Treatment. Solution heat treatment is practiced by plants in all of the aluminum forming subcategories. Solution heat treatment involves water quenching of the hot metal and results in substantial water use requirements. Due to the similarity in water use requirements among the various subcategories, the water use data were combined and analyzed as a single data set. The solution heat treatment operation and the BPT normalized discharge flow for the associated wastewater stream are described in conjunction with the Rolling with Neat Oils Subcategory.

Cleaning or Etching. Wastewater streams associated with cleaning or etching operations may include chemical baths, rinse water, and air pollution control scrubbers. Refer to the Rolling with Neat Oils section for a description of these wastewater streams and the associated BPT discharge flows.

Pollutants

The pollutants considered for regulation under BPT are listed in Section VI, along with an explanation of why they have been selected. The pollutants selected for regulation under BPT are chromium (total), cyanide (total), zinc, aluminum, oil and grease, TSS, and pH. The toxic organic pollutants, cadmium, copper, lead, nickel, and selenium, listed in Section VI are not specifically regulated under BPT for the reasons explained in Section X (p. 1058).

Table IX-12 lists the pollutants considered for regulation associated with each wastewater stream in the Forging Subcategory and the corresponding maximum and minimum concentrations detected for each pollutant.

Treatment Train

The BPT model treatment train for the Forging Subcategory consists of preliminary treatment when necessary, specifically emulsion breaking and skimming, hexavalent chromium reduction, and cyanide precipitation. The effluent from preliminary treatment is combined with other wastewaters for common treatment by skimming and lime and settle. Sawing spent lubricants require emulsion breaking and skimming and may require hexavalent chromium reduction prior to combined treatment by skimming and lime and settle. Solution heat treatment contact cooling water may require cyanide precipitation, while cleaning or etching and forging scrubber wastewaters may require chromium reduction in addition to cyanide precipitation. Following the preliminary treatment, these wastewaters are then treated by skimming and lime and settle. The treatment train is presented in Figure IX-4.

Effluent Limitations

Table VII-20 (p. 807) presents the treatment effectiveness of BPT model treatment train for pollutant parameters considered in the Forging Subcategory. Effluent concentrations (one day maximum and ten day average values) are multiplied by the normalized discharge flows summarized in Table IX-11 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table IX-13.

Benefits

BPT level costs and benefits are tabulated along with BAT costs and benefits in Section X. As shown in Table X-6 (p. 1082), the application of BPT level technology to the total Forging Subcategory will remove approximately 767,120.6 kg/yr (1.688

million lb/yr) of pollutants. As shown in Table X-1 (p. 1074), the corresponding capital and annual costs (1982 dollars) for this removal are $11.45 million and $8.28 million per year, respectively.

DRAWING WITH NEAT OILS SUBCATEGORY

Production Operations and Discharge Flows

The primary operation in this subcategory is drawing aluminum using neat oil as a lubricant. Other subsidiary production operations in this subcategory include annealing, stationary casting, homogenizing, artificial aging, degreasing, sawing, swaging, continuous rod casting, solution heat treatment, and cleaning or etching. These unit operations were tabulated with the waste streams generated and production normalizing parameters in Section IV (p. 160). Table IX-14 lists these production operations, separating them into core and ancillary operations, and identifies the production normalized wastewater flows generated from each. The core allowance for the Drawing with Neat Oils Subcategory is 49.8 l/kkg (11.95 gal/ton). This one allowance represents the sum of the individual allowances for the core waste streams which have a discharge allowance. These streams are sawing spent lubricants and miscellaneous nondescript wastewater sources. The following paragraphs discuss these operations and wastewater discharge flows.

Core Operations

Drawing with Neat Oils. Of the 64 plants using neat oils as drawing lubricants, none were found to discharge this oil either directly or indirectly. The most common practice appears to be filtration and recycle. Frequently, carryover is the only method of disposal, but in other cases the oil is periodically disposed of either to a contractor or an incinerator. A number of telephone contacts with industry and trade associations confirmed this information. Because no plants are known to be discharging drawing neat oils to receiving waters or a POTW, the stream has been assigned a zero discharge allowance.

Annealing. Annealing is a type of heat treatment which is often associated with aluminum forming operations. The basic operation is dry, although water can be used to clean furnace off gases. In the Drawing with Neat Oils Subcategory, no annealing operation uses water for scrubbing; therefore, this stream is assigned a zero discharge allowance and is included in the core for regulatory convenience.

Stationary Casting. Stationary casting is associated with most of the aluminum forming subcategories and is designed as a zero discharge process. The operation is similar throughout the industry and was never found to generate a wastewater stream. Therefore, stationary casting is included in the core of the Drawing with Neat Oils Subcategory with no wastewater discharge allowance. For a more detailed description, refer to the discussion of stationary casting operations associated with the Rolling with Neat Oils Subcategory.

Homogenizing. Homogenizing is a heat treatment process that frequently follows casting. For the reasons discussed previously, it has been assigned a zero discharge allowance and is, therefore, included as a core stream in this subcategory. Homogenization operations are similar throughout the industry. For a more detailed description of the operation, refer to the Rolling with Neat Oils Subcategory discussion.

Artificial Aging. Artificial aging, a common heat treatment, does not generate wastewater. Therefore, artificial aging is included in the core of the Drawing with Neat Oils Subcategory as a regulatory convenience.

Degreasing. All plants in this subcategory reporting degreasing operations indicated that no wastewater is discharged; therefore, this stream has no wastewater discharge allowance. Degreasing operations are similar in all subcategories of the industry. For a more detailed description of the operation, refer to the Rolling with Neat Oils section.

Sawing. Because sawing is typically associated with drawing operations, it has been included in the core of the Drawing with Neat Oils Subcategory. On the basis of available data, sawing operations and lubricant discharge practices appear to be similar throughout the aluminum forming category. For a description of the normalized discharge flow associated with sawing, refer to the previous discussion in the Rolling with Neat Oils section.

Swaging. Swaging operations point the end of tube or wire to prepare it for drawing. Although swaging may require lubricants, no plant was found to discharge wastewater from this operation. Therefore, zero discharge of wastewater is considered appropriate.

Miscellaneous Nondescript Wastewater Sources. An allowance for miscellaneous wastewater sources is included in the core of each subcategory. A description of this allowance and the BPT discharge flow designated for these miscellaneous wastewater sources was presented previously in the discussion of the Rolling with Neat Oils Subcategory.

Ancillary Operations

Continuous Rod Casting Cooling. A method of casting rod in preparation for drawing is continuous casting. A stream of water is circulated through the casting wheel to cool the molten aluminum as it is cast. This water is in theory noncontact cooling water; however, many of the plant personnel contacted have indicated that it is impossible to prevent the water from coming into contact with the product. Only one of the aluminum forming plants surveyed supplied sufficient information to calculate a production normalized flow. The BPT normalized flow, 1,555 l/kkg (249.9 gal/ton) of aluminum cast is based on these data, as shown in Table V-68 (p. 426).

Data obtained from dcp's for primary aluminum plants were subsequently considered. Two plants provided sufficient information to calculate a discharge flow. One plant reported a production normalized discharge flow of 415 l/kkg and the other 11.3 l/kkg. Both of the primary aluminum plants employ a high degree of recycle (99 percent). The former plant uses approximately the same amount of water as the single aluminum forming plant. The latter plant uses approximately 40 times as much water as the other two plants. There is no apparent reason to believe that the casting operations at these three plants are different and that they would require significantly differing amounts of water. As such, the Agency believes that the primary aluminum data support the selection of the BPT normalized flow based on the aluminum forming data.

Continuous Rod Casting Lubricant. An emulsion is used as a lubricant for rolling of aluminum rod, part of the rod casting process, and not to be confused with the Rolling with Emulsions Subcategory. Of the three plants with continuous rod casting operations, one reported 100 percent recycle of their lubricants without discharge, and two plants periodically dispose of this waste stream with contractor hauling. Neither of these two plants reported sufficient information to calculate a discharge flow. The Agency has transferred the normalized discharge flow for continuous sheet casting lubricant, 1.9 l/kkg (0.442 gal/ton) of aluminum cast to apply to continous rod casting. The Agency believes these processes are similar and the amount of lubricant required per pound of sheet cast is comparable to the lubricant used per pound of rod produced.

Solution Heat Treatment. Solution heat treatment is practiced by plants in all of the aluminum forming subcategories. Solution heat treating involves water quenching of the heated metal and results in substantial water use requirements. Due to the similarity in water use requirements among the various subcategories, the water use data were combined and analyzed as a single data set. The solution heat treatment operation and the BPT normalized data flow for the associated wastewater stream are described in conjunction with the Rolling with Neat Oils Subcategory.

Cleaning or Etching. Wastewater streams associated with cleaning or etching operations may include chemical baths, rinse water, and air pollution control scrubbers. Refer to the Rolling with Neat Oils section for a description of these wastewater streams and the associated BPT discharge flows.

Pollutants

The pollutants considered for regulation under BPT are listed in Section VI, along with an explanation of why they have been selected. The pollutants selected for regulation under BPT are chromium (total), cyanide (total), zinc, aluminum, oil and grease, TSS, and pH. The toxic organic pollutants, cadmium, copper, lead, nickel, and selenium, listed in Section VI are not regulated under BPT for the reasons explained in Section X (p. 1058).

Table IX-15 lists the pollutants considered for regulation associated with each wastewater stream in the Drawing with Neat Oils Subcategory and the corresponding maximum and minimum concentrations detected for each pollutant.

Treatment Train

The BPT model treatment train for the Drawing with Neat Oils Subcategory consists of preliminary treatment when necessary, specifically emulsion breaking and skimming, hexavalent chromium reduction, and cyanide precipitation. The effluent from preliminary treatment is combined with other wastewaters for common treatment by skimming and lime and settle. Sawing spent lubricants require emulsion breaking and skimming and may require hexavalent chromium reduction prior to combined treatment by skimming and lime and settle. Solution heat treatment contact cooling water may require cyanide precipitation, while cleaning or etching wastewaters may require chromium reduction in addition to cyanide precipitation. Following the preliminary treatment, these wastewaters are then treated by skimming and lime and settle. The treatment train is presented in Figure IX-5.

Effluent Limitations

Table VII-20 (p. 807) presents the treatment effectiveness of the BPT model treatment train for pollutant parameters considered in the Drawing with Neat Oils Subcategory. Effluent concentrations (one day maximum and ten day average values) are multiplied by the normalized discharge flows summarized in Table IX-14 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table IX-16.

Benefits

In establishing BPT, EPA must consider the cost of treatment and control in relation to the effluent reduction benefits. BPT costs and benefits are tabulated along with BAT costs and benefits in Section X. As shown in Table X-7 (p. 1085), the application of BPT to the total Drawing with Neat Oils Subcategory will remove approximately 756,582.6 kg/yr (1.664 million lb/yr) of pollutants. As shown in Table X-1 (p. 1074), the corresponding capital and annual costs (1982 dollars) for this removal are $4.69 million and $2.94 million per year, respectively. As shown in Table X-12 (p. 1095), the application of BPT to direct dischargers only, will remove approximately 536,194.5 kg/yr (1.180 million lb/yr) of pollutants. As shown in Table X-2 (p. 1075), the corresponding capital and annual costs (1982 dollars) for this removal are $3.03 million and $1.75 million per year, respectively. The Agency concludes that these pollutant removals justify the costs incurred by plants in the Drawing with Neat Oils Subcategory.

DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Production Operations and Discharge Flows

The primary operation in this subcategory is drawing aluminum using emulsified oil or soap as a lubricant. Other subsidiary production operations in this subcategory include annealing, stationary casting, homogenizing, artificial aging, degreasing, sawing, continuous rod casting, solution heat treatment, and cleaning or etching. These unit operations were tabulated with the waste streams generated and production normalizing parameters in Section IV (p. 162). Table IX-17 lists these production operations, separating them into core and ancillary operations, and identifies the production normalized wastewater flows generated from each. The core allowance for the Drawing with Emulsions or Soaps Subcategory is 466.3 l/kkg (111.9 gal/ton). This one allowance represents the sum of the individual allowances for the core waste streams which have a discharge allowance. These streams are drawing with emulsions or soaps spent lubricants, sawing spent lubricants and miscellaneous nondescript wastewater sources. The following paragraphs discuss these operations and wastewater discharge flows.

Core Operations

Drawing with Emulsions or Soaps. Of the 13 plants which use emulsions or soap solutions for drawing, eight provided enough data to calculate normalized discharge flows. Table IX-18 shows the wide range of values.

Surface area of product, or wire gauge, is one factor that affects water use. However, there are also many other factors, including wire hardness, reduction in diameter per die stage, drawing speed, alloys used, and mechanisms for recovering and reusing the lubricant. The Agency examined the dcp information and found that there are plants that draw fine wire gauges and are currently meeting the BPT flows and limitations; thus, it is demonstrated that plants drawing fine wire are able to meet the limitations and flows.

Comparison of Table V-26 (p. 254) and Table IX-18 shows that plant 8 does not recycle its soap solutions, while plant 6 does recycle soap solutions. This partially explains the extremely large wastewater flow of plant 8 and is the reason for eliminating plant 8's flow from the mean flow calculation. A comparison of wastewater from plant 6 using soap as a lubricant and wastewater from other plants using emulsions shows that the type of lubricant does not seem to influence the lubricant normalized discharge flow.

The mean normalized discharge flow of the six plants that recycle and discharge drawing emulsions has been chosen as the basis of BPT, 416.5 l/kkg (99.89 gal/ton) of aluminum drawn.

Annealing. Annealing is a type of heat treatment which is often associated with all aluminum forming operations. The basic operation is dry, although water can be used to clean furnace off gases. In the Drawing with Emulsions or Soaps Subcategory, no annealing operation uses water for scrubbing; therefore, this stream is assigned a zero discharge allowance and is included as a core stream for regulatory convenience.

Stationary Casting. Stationary casting is associated with most of the aluminum forming subcategories and is designed as a zero discharge operation. The operation is similar throughout the industry and was never found to generate a wastewater stream. Stationary casting is, therefore, included in the core of the Drawing with Emulsions or Soaps Subcategory with no wastewater discharge allowance. For a further description, refer to the discussion of stationary casting operations associated with the Rolling with Neat Oils Subcategory.

Homogenizing. Homogenizing is a heat treatment process that frequently follows casting. For the reasons discussed previously, it has been assigned a zero discharge allowance and is, therefore, included as a core stream in this subcategory. Homogenization operations are similar throughout the industry. For a more detailed description of the operation, refer to the Rolling with Neat Oils Subcategory discussion.

Artificial Aging. Artificial aging, a common heat treatment, does not generate wastewater. Therefore, artificial aging is included in the core of the Drawing with Emulsions or Soaps Subcategory as a regulatory convenience.

Degreasing. All plants surveyed in this subcategory reporting degreasing operations indicated that no wastewater is discharged; therefore, this stream has no wastewater discharge allowance. Degreasing operations are similar in all subcategories of the industry. For a more detailed description of the operation, refer to the Rolling with Neat Oils section.

Sawing. Because sawing is typically associated with drawing operations, it has been included in the core of the Drawing with Emulsions or Soaps Subcategory. On the basis of available data, sawing operations and lubricant discharge practices appear to be similar throughout the aluminum forming category. For a description of the normalized discharge flow associated with sawing, refer to the previous discussion under Rolling with Neat Oils.

Swaging. Swaging operations point the end of tube or wire to prepare it for drawing. Although swaging may require lubricants, no plant was found to discharge wastewater from this operation. Therefore, zero discharge of wastewater is considered appropriate.

Miscellaneous Nondescript Wastewater Sources. An allowance for miscellaneous wastewater sources is included in the core of each subcategory. A description of this allowance and the BPT discharge flow designated for these miscellaneous wastewater sources was presented in the discussion of the Rolling with Neat Oils Subcategory.

Ancillary Operations

Continuous Rod Casting Cooling. Rod casting forms the metal in preparation for rolling or drawing. In the process, cooling water is circulated through the casting wheel and often contacts the molten metal. As discussed in the Drawing with Neat Oils section, only one plant supplied sufficient information to calculate a normalized flow which is designated the BPT discharge flow of 1,042 l/kkg (249.9 gal/ton) of aluminum cast.

Continuous Rod Casting Lubricant. Part of the rod casting process involves rolling the cast aluminum with an emulsion as a lubricant. Of the three plants with continuous rod casting operations, one reported 100 percent recycle of lubricants, and two plants periodically dispose of this waste stream with contractor hauling. As discussed in the Drawing with Neat Oils section, it is assumed that the discharge flow is equal to that of continuous sheet casting lubricant, 1.843 l/kkg (0.442 gal/ton) of aluminum cast.

Solution Heat Treatment. Solution heat treatment is practiced by plants in all of the aluminum forming subcategories. Solution heat treating involves water quenching of the heated metal and results in substantial water use requirements. Due to the similarity in water use requirements among the various subcategories, the water use data were combined and analyzed as a single data set. The solution heat treatment operation and the BPT normalized data flow for the associated wastewater stream are described in conjunction with the Rolling with Neat Oils Subcategory.

Cleaning or Etching. Wastewater streams associated with cleaning or etching operations may include chemical baths, rinse water, and air pollution control scrubbers. Refer to the Rolling with Neat Oils section for a description of these wastewater streams and the associated BPT discharge flows.

Pollutants

The pollutants considered for regulation under BPT are listed in Section VI, along with an explanation of why they have been selected. The pollutants selected for regulation under BPT are chromium (total), cyanide (total), zinc, aluminum, oil and grease, TSS, and pH. The toxic organic pollutants, cadmium, copper, lead, nickel, and selenium, listed in Section VI are not regulated under BPT for the reasons explained in Section X (p. 1058).

Table IX-19 lists the pollutants considered for regulation associated with each wastewater stream in the Drawing with Emulsions or Soaps Subcategory and the corresponding maximum and minimum concentrations detected for each pollutant.

Treatment Train

The BPT model treatment train for the Drawing with Emulsions or Soaps Subcategory consists of preliminary treatment when necessary, specifically emulsion breaking and skimming, hexavalent chromium reduction, and cyanide precipitation. The effluent from preliminary treatment is combined with other wastewaters for common treatment by skimming and lime and settle. Sawing spent lubricants require emulsion breaking and skimming and may require hexavalent chromium reduction prior to combined treatment by skimming and lime and settle. Solution heat treatment contact cooling water may require cyanide precipitation, while cleaning or etching wastewaters may require chromium reduction in addition to cyanide precipitation. Following the preliminary treatment, these wastewaters are then treated by skimming and lime and settle. The treatment train is presented in Figure IX-6.

Effluent Limitations

Table VII-20 (p. 807) presents the treatment effectiveness of the BPT model treatment train for pollutant parameters considered in the Drawing with Emulsions Subcategory. Effluent concentrations (one day maximum and ten day average values) are multiplied by the normalized discharge flows summarized in Table IX-17 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table IX-20.

Benefits

In establishing BPT, EPA must consider the cost of treatment and control in relation to the effluent reduction benefits. BPT costs and benefits are tabulated along with BAT costs and benefits in Section X. As shown in Table X-8 (p. 1087), the application of BPT to the total Drawing with Emulsions or Soaps Subcategory will remove approximately 134,342.9 kg/yr (0.296 million lb/yr) of pollutants. As shown in Table X-1 (p. 1074), the corresponding capital and annual costs (1982 dollars) for this removal are $1.05 million and $0.82 million per year, respectively. As shown in Table X-13 (p. 1097), the application of BPT to direct dischargers only, will remove approximately 53,036.9 kg/yr (0.117 million lb/yr) of pollutants. As shown in Table X-2 (p. 1075), the corresponding capital and annual costs (1982 dollars) for this removal are $0.73 million and $0.47 million per year, respectively. The Agency concludes that these pollutant removals justify the costs incurred by plants in the Drawing with Emulsions or Soaps Subcategory.

APPLICATION OF LIMITATIONS IN PERMITS

The purpose of these limitations (and standards) is to form a uniform basis for regulating wastewater effluent from the aluminum forming category. For direct dischargers, this is accomplished through NPDES permits. Since the aluminum forming category is regulated on an individual waste stream "building-block" approach, two examples of applying these limitations to determine the allowable discharge from aluminum forming facilities are included.

Some process wastewater streams may not be covered by this regulation or other effluent guidelines but are generated in the aluminum forming plant and must be dealt with either in the permit or pretreatment context. Whenever such wastewaters are encountered, the permit writer or control authority should take into account the minimum necessary water use for the process operation and the treatment effectiveness of the model technology using these factors to derive a mass discharge amount for the unregulated process wastewater. As an example painting, which is not specifically regulated in aluminum forming sometimes generates a wastewater. Metal preparation prior to painting such as chromate conversion coating should be included as an etch line operation while other process wastewater such as a water spray curtain should be allowed an added discharge allowance based on the minimum necessary water use and the appropriate treatment effectiveness.

Example 1

Plant X forms aluminum using an extrusion process and operates 250 days per year. The total plant production is 50,000 kkg/yr. All of the aluminum is degassed and cast by the direct chill method; 70 percent of the aluminum is solution heat treated; and 50 percent of the aluminum is etched with caustic. The plant has a degassing scrubber, and the etch line consists of a single bath followed by a two-stage rinse. Table IX-21 illustrates the calculation of the allowable BPT discharge of TSS.

The daily production from the extrusion operation would equal 50,000 off-kkg/yr divided by 250 days/yr to get 200 off-kkg/day. This production rate is then multiplied by the extrusion core limitation (mg/off-kkg) to get the daily discharge limit for the core at Plant X. A production of 200 off-kkg/day is also used to multiply with the limitation of direct chill casting, since 100 percent of the direct chill casting product is extruded. To determine the mass of aluminum that is processed through solution heat treatment the mass of aluminum extruded (200 off-kkg/day) is multiplied by 70 percent to achieve a production rate of 140 off-kkg/day. The same procedure is followed for the cleaning or etching operation and the sum of the daily limits for the individual operations becomes the plant limit.

Example 2

Plant Y, which operates 300 days per year, forms 10,000 off-kkg/yr of aluminum sheet by rolling with emulsions and also forms 2,000 off-kkg/yr of aluminum by drawing with emulsions. All of the rolled aluminum is cast by the direct chill method; all of the drawn aluminum is cast by the continuous rod casting method; 70 percent of the rolled aluminum is solution heat treated; 30 percent of the rolled aluminum is etched with caustic; and 5 percent of the drawn aluminum is etched with caustic. The etch line consists of a caustic bath followed by a single-stage rinse followed by a detergent bath followed by a second single-stage rinse. Table IX-22 illustrates the calculation of the allowable BPT discharge of zinc.

The first step in determining the daily limits for Plant Y is to put the production in terms of off-kkg/day. The plant produces 10,000 kkg/yr of aluminum sheet, all of which is cast on-site by direct chill casting. Thus, the daily production for direct chill casting is 10,000 off-kkg/yr divided by 300 days/yr or 33.3 off-kkg/day. Following the casting operation the aluminum ingot is heated then processed through the rolling mill to produce plate and removed to cool. The aluminum plate is then returned to the rolling mill and processed once more to produce sheet, thus the same off mass of aluminum undergoes two process cycles. The production parameter used to obtain the daily limit from the rolling process is two times the production of the direct chill casting process or 66.6 off-kkg/day. The production and daily limits are shown on Table IX-22 for all of the operations performed at Plant Y.

Table IX-1

PRODUCTION OPERATIONS - ROLLING WITH NEAT OILS SUBCATEGORY

Operation	Waste Stream	Normalized BPT Discharge 1/kkg	Normalized BPT Discharge (gpt)	Production Normalizing Parameter
Core				
Rolling with neat oils	Spent lubricant	0	(0)	
Roll grinding	Spent emulsion	5.50	(2.20)	Mass of aluminum rolled with neat oil
Stationary casting	None	0	(0)	
Homogenizing	None	0	(0)	
Artificial aging	None	0	(0)	
Degreasing	Spent solvents	0	(0)	
Sawing	Spent lubricant	4.807	(1.153)	Mass of aluminum rolled with neat oil
Miscellaneous nondescript wastewater sources	Various	45	(10.80)	Mass of aluminum rolled with neat oil
	Total core without an annealing furnace scrubber	55.31	(13.27)	
Annealing	Atmosphere scrubber liquor	26.35	(6.320)	Mass of aluminum rolled with neat oil
	Total core with an annealing furnace scrubber	81.66	(19.60)	

Table IX-1 (Continued)

PRODUCTION OPERATIONS - ROLLING WITH NEAT OILS SUBCATEGORY

Operation	Waste Stream	Normalized BPT Discharge 1/kkg	Normalized BPT Discharge (gpt)	Production Normalizing Parameter
Ancillary				
Continuous sheet casting	Spent lubricant	1.964	(0.471)	Mass of aluminum cast by continuous methods
Solution heat treatment	Contact cooling water	7,705	(1,848)	Mass of aluminum quenched
Cleaning or etching	Bath	179	(42.96)	Mass of aluminum cleaned or etched
	Rinse	13,912	(3,339)	Mass of aluminum cleaned or etched
	Scrubber liquor	15,900	(3,816)	Mass of aluminum cleaned or etched

Table IX-2

COMPARISON OF WASTEWATER DISCHARGE RATES FROM CLEANING OR ETCHING RINSE STREAMS

Plant	Bath Stages	Wastewater Per Stage 1/kkg	gal/ton	Cleaning or Etching Baths Acid	Caustic	Detergent	Other	Associated Product Coil	Extrusion	Forging	Drawn	Other
1	1	1.430	0.3430		X	X		X				
2	1	2.635	0.6320				X				X	
3	1	14.48	3.472	X				X				
4	1	61.00	14.63		X	X			X			
5	1	80.05	19.20	X	X				X	X	X	
6	1	102.1	24.49	X		X					X	
7	1	178.0	42.70				X	X				
8	1	333.6	80.00	X					X			
9	1	500.3	120.0	X	X					X		
10	2	500.3	120.0	X	X							X
11	1	558.3	133.3		X							X
12	1	600.0	143.9	X				X				
13	1	938.1	225.0		X	X		X				
14	2	1,163	279.0	X	X						X	
15	2	1,313	315.0	X	X				X		X	
16	2	1,591	381.6	X	X						X	
17	4	1,780	427.0	X	X					X		
18	3	2,110	506.0	X	X					X		
19	1	2,330	558.8	X				X				
20	1	5,003	1,200		X					X		
21	2	5,212	1,250	X	X					X		
22	2	5,683	1,363	X	X					X		
23	2	10,670	2,560	X	X					X		
24	1	14,480	3,473				X	X				
25	2	16,120	3,865	X	X					X		
26	3	20,850	5,000	X	X		X			X		
27	1	23,350	5,600		X			X				
28	4	23,520	5,640	X	X	X	X		X			
29	3	36,390	8,727				X			X		
30	1	43,950	10,540	X					X			
31	1	63,920	15,330		X				X			
32	2	75,430	18,090	X	X					X		
33	1	89,350	21,430		X					X		
34	2	125,100	30,000	X	X	X				X		

Note: This table includes data from four plants which have both cleaning and etch line rinse dischargers.

Table IX-3

CONCENTRATION RANGE OF POLLUTANTS CONSIDERED FOR BPT REGULATION IN CORE AND ANCILLARY WASTE STREAMS - ROLLING WITH NEAT OILS SUBCATEGORY

Waste Stream	Cadmium (mg/l)	Total Chromium (mg/l)	Copper (mg/l)	Total Cyanide (mg/l)	Lead (mg/l)	Nickel (mg/l)
Roll Grinding Spent Emulsions	<0.01 - 0.013	0.057 - 0.360	<0.050	<0.020	0.050 - <0.100	<0.020 - 0.050
Sawing Spent Lubricants	<0.012 - 0.020	<0.020 - 0.160	0.100 - 1.250	<0.020	<0.100 - 0.500	<0.050 - 0.122
Annealing Atmosphere Scrubber Liquor	---	0.016	0.021	---	0.016	---
Continuous Sheet Casting Spent Lubricants[A]	<0.0002 - 0.180	<0.001 - 1	ND - 7.40	0.016 - 2.5	<0.002 - 56.90	<0.001 - 0.28
Solution Heat Treatment Contact Cooling	<0.0005 - 0.012	0.002 - 72	0.001 - 0.38	<0.001 - 530	ND - 17	<0.001 - 0.040
Cleaning or Etching Bath	0.005 - 3.000	0.020 - 10	<0.05 - 20	<0.001 - 0.408	0.400 - 90.0	0.001 - 486
Cleaning or Etching Rinse	<0.0005 - 0.200	0.007 - 280	0.0011 - 480	0.00002 - 0.042	0.01 - 11	<0.001 - 160
Cleaning or Etching Scrubber Liquor	---	---	0.01	---	---	---

ND = Not Detected.

[A] This stream was assumed to be similar to Rolling with Emulsions Spent Emulsions.

Table IX-3 (Continued)

CONCENTRATION RANGE OF POLLUTANTS CONSIDERED FOR
BPT REGULATION IN CORE AND ANCILLARY WASTE STREAMS -
ROLLING WITH NEAT OILS SUBCATEGORY

Waste Stream	Zinc (mg/l)	Aluminum (mg/l)	Oil and Grease (mg/l)	TSS (mg/l)	pH (units)
Roll Grinding Spent Emulsions	<0.020 - 0.520	2.30 - 554	11 - 780	9.0 - 120	8.72 - 9.51
Sawing Spent Lubricants	0.180 - 12.9	2.4 - 185	4,200 - 23,000	495 - 3,200	6.89 - 8.93
Annealing Atmosphere Scrubber Liquor	0.220	<0.5	---	4	6.2
Continuous Sheet Casting Spent Lubricants[A]	<0.005 - 16	20 - 350	1,277 - 802,000	0.540 - 124,540	6.9 - 9.74
Solution Heat Treatment Contact Cooling	<0.010 - 5.2	<0.1 - 9	1.5 - 370	<1 - 240	7 - 9.6
Cleaning or Etching Bath	<0.010 - <30.00	0.300 - 70,000	<1 - 1,900	1.0 - 1,540	0.15 - 11.4
Cleaning or Etching Rinse	<0.01 - 410	<0.01 - 1,300	<1 - 490	<1 - 3,640	0.55 - 11.8
Cleaning or Etching Scrubber Liquor	---	5.1	13	12	8.1

ND = Not Detected.

[A] This stream was assumed to be similar to Rolling with Emulsions Spent Emulsions.

Table IX-4

BPT MASS LIMITATIONS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Rolling With Neat Oils - Core Waste Streams Without An Annealing Furnace Scrubber

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum rolled with neat oils		
118	Cadmium	0.019	0.008
119	Chromium*	0.024	0.010
120	Copper	0.105	0.055
121	Cyanide*	0.016	0.007
122	Lead	0.023	0.011
124	Nickel	0.106	0.070
125	Selenium	0.068	0.030
128	Zinc*	0.081	0.034
	Aluminum*	0.356	0.174
	Oil & Grease*	1.106	0.664
	Total Suspended Solids*	2.268	1.079
	pH*	Within the range of 7.0 to 10.0 at all times.	

Rolling With Neat Oils - Core Waste Streams With An Annealing Furnace Scrubber

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum rolled with neat oils		
118	Cadmium	0.027	0.012
119	Chromium*	0.036	0.015
120	Copper	0.155	0.082
121	Cyanide*	0.024	0.010
122	Lead	0.035	0.017
124	Nickel	0.157	0.104
125	Selenium	0.100	0.045
128	Zinc*	0.119	0.050
	Aluminum*	0.525	0.257
	Oil & Grease*	1.634	0.980
	Total Suspended Solids*	3.348	1.593
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-4 (Continued)

BPT MASS LIMITATIONS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Continuous Sheet Casting - Spent Lubricant

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.0007	0.00035
119 Chromium*	0.0009	0.0004
120 Copper	0.0037	0.0020
121 Cyanide*	0.0006	0.00024
122 Lead	0.0008	0.0004
124 Nickel	0.0038	0.0025
125 Selenium	0.0024	0.0011
128 Zinc*	0.0029	0.0012
Aluminum*	0.0127	0.0063
Oil & Grease*	0.0393	0.0236
Total Suspended Solids*	0.0805	0.0383
pH*	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched		
118 Cadmium	2.62	1.16
119 Chromium*	3.39	1.39
120 Copper	14.64	7.71
121 Cyanide*	2.24	0.93
122 Lead	3.24	1.54
124 Nickel	14.79	9.79
125 Selenium	9.48	4.24
128 Zinc*	11.25	4.70
Aluminum*	49.55	24.66
Oil & Grease*	154.10	92.46
Total Suspended Solids*	315.91	150.25
pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-4 (Continued)

BPT MASS LIMITATIONS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Bath

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.035
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.262	0.109
	Aluminum*	1.150	0.573
	Oil & Grease*	3.580	2.148
	Total Suspended Solids*	7.339	3.491
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	4.730	2.087
119	Chromium*	6.121	2.504
120	Copper	26.433	13.912
121	Cyanide*	4.034	1.669
122	Lead	5.843	2.783
124	Nickel	26.711	17.668
125	Selenium	17.112	7.652
128	Zinc*	20.312	8.486
	Aluminum*	89.454	44.518
	Oil & Grease*	278.240	166.944
	Total Suspended Solids*	570.390	271.284
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-4 (Continued)

BPT MASS LIMITATIONS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	5.406	2.385
119	Chromium*	6.996	2.862
120	Copper	30.210	15.900
121	Cyanide*	4.611	1.908
122	Lead	6.678	3.180
124	Nickel	30.528	20.067
125	Selenium	19.557	8.745
128	Zinc*	23.214	9.699
	Aluminum*	102.237	50.880
	Oil & Grease*	318.000	190.800
	Total Suspended Solids*	651.900	310.050
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-5

PRODUCTION OPERATIONS - ROLLING WITH EMULSIONS SUBCATEGORY

Operation	Waste Stream	Normalized BPT Discharge 1/kkg	(gpt)	Production Normalizing Parameter
Core				
Rolling with emulsions	Spent emulsion	74.51	(17.87)	Mass of aluminum rolled with emulsions
Roll grinding	Spent emulsion	5.50	(2.20)	Mass of aluminum rolled with emulsions
Annealing	None	0	(0)	
Stationary casting	None	0	(0)	
Homogenizing	None	0	(0)	
Artificial aging	None	0	(0)	
Degreasing	None	0	(0)	
Sawing	Spent lubricant	4.807	(1.153)	Mass of aluminum rolled with emulsions
Miscellaneous nondescript wastewater sources	Various	45	(10.80)	Mass of aluminum rolled with emulsions
	Total Core	129.82	(31.16)	
Ancillary				
Direct chill casting	Contact cooling water	1,329	(318.9)	Mass of aluminum cast by direct chill method
Solution heat treatment	Contact cooling water	7,705	(1,848)	Mass of aluminum quenched
Cleaning or etching	Bath	179	(42.96)	Mass of aluminum cleaned or etched
	Rinse	13,912	(3,339)	Mass of aluminum cleaned or etched
	Scrubber Liquor	15,900	(3,816)	Mass of aluminum cleaned or etched

Table IX-6

CONCENTRATION RANGE OF POLLUTANTS CONSIDERED FOR BPT REGULATION IN CORE AND ANCILLARY WASTE STREAMS - ROLLING WITH EMULSIONS SUBCATEGORY

Waste Stream	Cadmium (mg/l)	Total Chromium (mg/l)	Copper (mg/l)	Total Cyanide (mg/l)	Lead (mg/l)	Nickel (mg/l)
Rolling Spent Emulsions	<0.0002 - 0.180	<0.001 - 1	ND - 7.40	0.016 - 2.5	<0.002 - 56.90	<0.001 - 0.28
Roll Grinding Spent Emulsions	<0.01 - 0.013	0.057 - 0.360	<0.050	<0.020	0.050 - <0.100	<0.020 - 0.050
Sawing Spent Lubricants	0.012 - 0.020	<0.020 - 0.160	0.100 - 1.250	<0.020	<0.100 - 0.500	<0.050 - 0.122
Direct Chill Casting Contact Cooling	<0.0005 - 0.020	<0.001 - 1.6	0.004 - 0.030	---	0.002 - 0.100	<0.001 - 0.020
Solution Heat Treatment Contact Cooling	<0.0005 - 0.012	0.002 - 72	0.001 - 0.38	<0.001 - 530	ND - 17	<0.001 - 0.040
Cleaning or Etching Bath	0.005 - 3.000	0.020 - 10.00	<0.05 - 20	<0.001 - 0.408	0.400 - 90.0	0.001 - 486
Cleaning or Etching Rinse	<0.0005 - 0.200	0.007 - 280	0.0011 - 480	0.00002 - 0.042	0.01 - 11	<0.001 - 160
Cleaning or Etching Scrubber Liquor	---	---	0.01	---	---	---

ND = Not Detected.

Table IX-6 (Continued)

CONCENTRATION RANGE OF POLLUTANTS CONSIDERED FOR BPT REGULATION IN CORE AND ANCILLARY WASTE STREAMS - ROLLING WITH EMULSIONS SUBCATEGORY

Waste Stream	Zinc (mg/l)	Aluminum (mg/l)	Oil and Grease (mg/l)	TSS (mg/l)	pH (units)
Rolling Spent Emulsions	<0.005 - 16	20 - 350	1,277 - 802,000	0.540 - 124,540	6.9 - 9.74
Roll Grinding Spent Emulsions	<0.020 - 0.520	2.30 - 554	11 - 780	9.0 - 120	8.72 - 9.51
Sawing Spent Lubricants	0.180 - 12.9	2.4 - 185	4,200 - 23,000	495 - 3,200	6.89 - 8.93
Direct Chill Casting Contact Cooling	<0.010 - 1.0	<0.050 - 2	<5 - 236	<1 - 220	6 - 8.4
Solution Heat Treatment Contact Cooling	<0.010 - 5.2	<0.1 - 9	1.5 - 370	<1 - 240	7 - 9.6
Cleaning or Etching Bath	<0.010 - <30.00	0.300 - 70,000	<1 - 1,900	1.0 - 1,540	0.15 - 11.4
Cleaning or Etching Rinse	<0.01 - 410	<0.01 - 1,300	<1 - 490	<1 - 3,640	0.55 - 11.8
Cleaning or Etching Scrubber Liquor	---	5.1	13	12	8.1

ND = Not Detected.

Table IX-7

BPT MASS LIMITATIONS FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Rolling With Emulsions - Core Waste Streams

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum rolled with emulsions		
118 Cadmium	0.044	0.019
119 Chromium*	0.057	0.024
120 Copper	0.247	0.130
121 Cyanide*	0.038	0.016
122 Lead	0.055	0.026
124 Nickel	0.249	0.165
125 Selenium	0.160	0.071
128 Zinc*	0.190	0.079
Aluminum*	0.835	0.416
Oil & Grease*	2.596	1.558
Total Suspended Solids*	5.323	2.531
pH*	Within the range of 7.0 to 10.0 at all times.	

Direct Chill Casting - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by direct chill methods		
118 Cadmium	0.452	0.199
119 Chromium*	0.585	0.239
120 Copper	2.525	1.329
121 Cyanide*	0.385	0.159
122 Lead	0.558	0.266
124 Nickel	2.552	1.688
125 Selenium	1.635	0.731
128 Zinc*	1.940	0.811
Aluminum*	8.545	4.253
Oil & Grease*	26.580	15.948
Total Suspended Solids*	54.489	25.916
pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-7 (Continued)

BPT MASS LIMITATIONS FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Solution Heat Treatment - Contact Cooling Water

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	2.620	1.156
119	Chromium*	3.390	1.387
120	Copper	14.640	7.705
121	Cyanide*	2.234	0.925
122	Lead	3.236	1.541
124	Nickel	14.794	9.785
125	Selenium	9.477	4.238
128	Zinc*	11.249	4.700
	Aluminum*	49.543	24.656
	Oil & Grease*	154.100	92.460
	Total Suspended Solids*	315.905	150.248
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.262	0.109
	Aluminum*	1.151	0.573
	Oil & Grease*	3.580	2.149
	Total Suspended Solids*	7.339	3.491
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-7 (Continued)

BPT MASS LIMITATIONS FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Cleaning or Etching - Rinse

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	4.730	2.087
119	Chromium*	6.121	2.504
120	Copper	26.433	13.912
121	Cyanide*	4.034	1.669
122	Lead	5.843	2.783
124	Nickel	26.711	17.668
125	Selenium	17.112	7.652
128	Zinc*	20.312	8.486
	Aluminum*	89.454	44.518
	Oil & Grease*	278.240	166.944
	Total Suspended Solids*	570.392	271.284
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	5.406	2.385
119	Chromium*	6.996	2.862
120	Copper	30.210	15.900
121	Cyanide*	4.611	1.908
122	Lead	6.678	3.180
124	Nickel	30.528	20.193
125	Selenium	19.577	8.745
128	Zinc*	23.214	9.699
	Aluminum*	102.237	50.880
	Oil & Grease*	318.000	190.800
	Total Suspended Solids*	651.900	310.050
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-8

PRODUCTION OPERATIONS - EXTRUSION SUBCATEGORY

Operation	Waste Stream	Normalized BPT Discharge		Production Normalizing Parameter
		1/kkg	(gpt)	
Core				
Extrusion	Die cleaning bath and rinse	38.52	(9.245)	Mass of aluminum extruded
	Die cleaning scrubber liquor	275.5	(66.08)	Mass of aluminum extruded
	Dummy block cooling	0	(0)	
Annealing	None	0	(0)	
Stationary casting	None	0	(0)	
Homogenizing	None	0	(0)	
Artificial aging	None	0	(0)	
Degreasing	Spent solvent	0	(0)	
Sawing	Spent lubricant	4.807	(1.153)	Mass of aluminum extruded
Miscellaneous nondescript wastewater sources	Various	45	(10.80)	Mass of aluminum extruded
	Total Core	363.82	(87.36)	
Ancillary				
Direct chill casting	Contact cooling water	1,329	(318.96)	Mass of aluminum cast by direct chill method
Extrusion press hydraulic	Fluid leakage	1,478	(354.7)	
Solution and press heat treatment	Contact cooling water	7,705	(1,848)	Mass of aluminum quenched
Cleaning or etching	Bath	179	(42.96)	Mass of aluminum cleaned or etched
	Rinse	13,912	(3,339)	Mass of aluminum cleaned or etched
	Scrubber liquor	15,900	(3,816)	Mass of aluminum cleaned or etched
Degassing	Scrubber liquor	2,607	(626)	Mass of aluminum degassed

Table IX-9

CONCENTRATION RANGE OF POLLUTANTS CONSIDERED FOR BPT REGULATION IN CORE AND ANCILLARY WASTE STREAMS - EXTRUSION SUBCATEGORY

Waste Stream	Cadmium (mg/l)	Total Chromium (mg/l)	Copper (mg/l)	Total Cyanide (mg/l)	Lead (mg/l)	Nickel (mg/l)
Extrusion Die Cleaning Bath	<0.010 - <2,100	0.900 - 8.0	<1.62 - 75.0	<0.02	1.02 - 10.0	<0.02 - <5.0
Extrusion Die Cleaning Rinse	<0.001 - 0.020	0.030 - 0.210	0.200 - 2.4	0.002 - 0.015	0.130 - 0.830	<0.005 - 0.10
Extrusion Die Cleaning Scrubber Liquor	<0.001 - 0.001	0.003 - 0.004	0.006	0.013 - 0.020	0.005 - 0.024	<0.001 - 0.003
Sawing Spent Lubricants	0.012 - 0.020	<0.020 - 0.160	0.100 - 1.250	<0.020	<0.100 - 0.500	<0.050 - 0.122
Direct Chill Casting Contact Cooling	<0.0005 - 0.020	<0.001 - 1.6	0.004 - 0.030	---	0.002 - 0.100	<0.001 - 0.020
Solution and Press Heat Treatment Contact Cooling	<0.0005 - 0.012	0.002 - 72	0.001 - 0.38	<0.001 - 530	ND - 17	<0.001 - 0.040
Cleaning or Etching Bath	0.005 - 3.000	0.020 - 10.00	<0.05 - 20	<0.001 - 0.408	0.400 - 90.0	0.001 - 486
Cleaning or Etching Rinse	<0.0005 - 0.200	0.007 - 280	0.0011 - 480	0.00002 - 0.042	0.01 - 11	<0.001 - 160
Cleaning or Etching Scrubber Liquor	---	---	0.01	---	---	---
Degassing Scrubber Liquor	0.0008 - 0.011	0.014 - 0.09	0.017 - 0.25	---	0.019 - 0.45	<0.001 - 0.023

ND = Not Detected

Table IX-9 (Continued)

CONCENTRATION RANGE OF POLLUTANTS CONSIDERED FOR BPT REGULATION IN CORE AND ANCILLARY WASTE STREAMS - EXTRUSION SUBCATEGORY

Waste Stream	Zinc (mg/l)	Aluminum (mg/l)	Oil and Grease (mg/l)	TSS (mg/l)	pH (units)
Extrusion Die Cleaning Bath	5.88 - 138	15,800 - 43,700	<1 - 22	310 - 3,830	12.03 - 12.92
Extrusion Die Cleaning Rinse	0.100 - 1.50	0.42 - 430	<1 - 17	26 - 130	7.8 - 11.7
Extrusion Die Cleaning Scrubber Liquor	0.02 - 0.04	0.60 - 1.3	5.7 - 160	1 - 4	8.1 - 8.3
Sawing Spent Lubricants	0.180 - 12.9	2.4 - 185	4,200 - 23,000	495 - 3,200	6.89 - 8.93
Direct Chill Casting Contact Cooling	<0.010 - 1.0	<0.050 - 2	<5 - 236	<1 - 220	6 - 8.4
Solution and Press Heat Treatment Contact Cooling	<0.010 - 5.2	<0.100 - 9	1.5 - 370	<1 - 240	7 - 9.6
Cleaning or Etching Bath	<0.010 - <30.00	0.300 - 70,000	<1 - 1,900	1.0 - 1,540	0.15 - 11.4
Cleaning or Etching Rinse	<0.01 - 410	<0.01 - 1,300	<1 - 490	<1 - 3,640	0.55 - 11.8
Cleaning or Etching Scrubber Liquor	---	5.1	13	12	8.1
Degassing Scrubber Liquor	0.13 - 1.3	<0.5 - 10	<5	<2 - 102	7.2 - 7.8

ND = Not Detected

Table IX-10

BPT MASS LIMITATIONS FOR THE EXTRUSION SUBCATEGORY

Extrusion - Core Waste Streams

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum extruded		
118 Cadmium	0.124	0.055
119 Chromium*	0.161	0.066
120 Copper	0.695	0.366
121 Cyanide*	0.106	0.044
122 Lead	0.153	0.073
124 Nickel	0.702	0.464
125 Selenium	0.450	0.201
128 Zinc*	0.534	0.223
Aluminum*	2.34	1.16
Oil & Grease*	7.314	4.338
Total Suspended Solids*	14.994	7.131
pH*	Within the range of 7.0 to 10.0 at all times.	

Direct Chill Casting - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by direct chill methods		
118 Cadmium	0.452	0.199
119 Chromium*	0.585	0.239
120 Copper	2.525	1.329
121 Cyanide*	0.385	0.159
122 Lead	0.558	0.266
124 Nickel	2.552	1.688
125 Selenium	1.635	0.731
128 Zinc*	1.940	0.811
Aluminum*	8.545	4.253
Oil & Grease*	26.580	15.948
Total Suspended Solids*	54.489	25.916
pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-10 (Continued)

BPT MASS LIMITATIONS FOR THE EXTRUSION SUBCATEGORY

Solution and Press Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	2.620	1.156
119	Chromium*	3.390	1.387
120	Copper	14.640	7.705
121	Cyanide*	2.234	0.925
122	Lead	3.236	1.541
124	Nickel	14.794	9.785
125	Selenium	9.477	4.238
128	Zinc*	11.249	4.700
	Aluminum*	49.543	24.656
	Oil & Grease*	154.100	92.460
	Total Suspended Solids*	315.905	150.248
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.261	0.109
	Aluminum*	1.151	0.573
	Oil & Grease*	3.580	2.148
	Total Suspended Solids*	7.339	3.491
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-10 (Continued)

BPT MASS LIMITATIONS FOR THE EXTRUSION SUBCATEGORY

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	4.730	2.087
119	Chromium*	6.121	2.504
120	Copper	26.433	13.912
121	Cyanide*	4.034	1.669
122	Lead	5.843	2.783
124	Nickel	26.711	17.668
125	Selenium	17.112	7.652
128	Zinc*	20.312	8.486
	Aluminum*	89.454	44.518
	Oil & Grease*	278.240	166.944
	Total Suspended Solids*	570.392	271.284
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	5.406	2.385
119	Chromium*	6.996	2.862
120	Copper	30.210	15.900
121	Cyanide*	4.611	1.908
122	Lead	6.678	3.180
124	Nickel	30.528	20.193
125	Selenium	19.557	8.745
128	Zinc*	23.214	9.699
	Aluminum*	102.237	50.880
	Oil & Grease*	318.000	190.800
	Total Suspended Solids*	651.900	310.050
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-10 (Continued)

BPT MASS LIMITATIONS FOR THE EXTRUSION SUBCATEGORY

Degassing - Scrubber Liquor

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum degassed		
118 Cadmium	0.887	0.391
119 Chromium*	1.148	0.470
120 Copper	4.957	2.609
121 Cyanide*	0.757	0.313
122 Lead	1.096	0.552
124 Nickel	5.009	3.313
125 Selenium	3.209	1.435
128 Zinc*	3.809	1.591
Aluminum*	16.776	8.349
Oil & Grease*	52.180	31.308
Total Suspended Solids*	106.969	50.876
pH*	Within the range of 7.0 to 10.0 at all times.	

Extrusion Press Hydraulic Fluid Leakage

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched		
118 Cadmium	0.503	0.222
119 Chromium*	0.650	0.266
120 Copper	2.808	1.478
121 Cyanide*	0.429	0.177
122 Lead	0.621	0.296
124 Nickel	2.838	1.877
125 Selenium	1.818	0.813
128 Zinc*	2.158	0.902
Aluminum*	9.504	4.730
Oil & Grease*	29.560	17.736
Total Suspended Solids*	60.60	28.821
pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-11

PRODUCTION OPERATIONS - FORGING SUBCATEGORY

Operation	Waste Stream	Normalized BPT Discharge 1/kkg	Normalized BPT Discharge (gpt)	Production Normalizing Parameter
Core				
Forging	None	0	(0)	
Annealing	None	0	(0)	
Artificial aging	None	0	(0)	
Degreasing	Spent solvent	0	(0)	
Sawing	Spent lubricant	4.807	(1.153)	Mass of aluminum forged
Miscellaneous nondescript wastewater sources	Various	45	(10.8)	Mass of aluminum forged
	Total Core	49.807	(11.95)	
Ancillary				
Forging	Scrubber liquor	1,547	(371.0)	Mass of aluminum forged
Solution heat treatment	Contact cooling water	7,705	(1,848)	Mass of aluminum quenched
Cleaning or etching	Bath	179	(42.96)	Mass of aluminum cleaned or etched
	Rinse	13,912	(3,339)	Mass of aluminum cleaned or etched
	Scrubber liquor	15,900	(3,816)	Mass of aluminum cleaned or etched

Table IX-12

CONCENTRATION RANGE OF POLLUTANTS CONSIDERED FOR BPT REGULATION IN CORE AND ANCILLARY WASTE STREAMS - FORGING SUBCATEGORY

Waste Stream	Cadmium (mg/l)	Total Chromium (mg/l)	Copper (mg/l)	Total Cyanide (mg/l)	Lead (mg/l)	Nickel (mg/l)
Sawing Spent Lubricants	0.012 - 0.020	<0.020 - 0.160	0.100 - 1.250	<0.020	<0.100 - 0.500	<0.050 - 0.122
Forging Scrubber Liquor	---	---	0.010	---	2.000	---
Solution Heat Treatment Contact Cooling	<0.0005 - 0.012	0.002 - 72	0.001 - 0.38	<0.001 - 530	ND - 17	<0.001 - 0.040
Cleaning or Etching Bath	0.005 - 3.000	0.020 - 10.00	<0.05 - 20	<0.001 - 0.408	0.400 - 90.0	0.001 - 486
Cleaning or Etching Rinse	<0.0005 - 0.200	0.007 - 280	0.0011 - 480	0.00002 - 0.042	0.01 - 11	<0.001 - 160
Cleaning or Etching Scrubber Liquor	---	---	0.01	---	---	---

ND = Not Detected.

Table IX-12 (Continued)

CONCENTRATION RANGE OF POLLUTANTS CONSIDERED FOR
BPT REGULATION IN CORE AND ANCILLARY WASTE STREAMS -
FORGING SUBCATEGORY

Waste Stream	Zinc (mg/l)	Aluminum (mg/l)	Oil and Grease (mg/l)	TSS (mg/l)	pH (units)
Sawing Spent Lubricants	0.180 - 12.9	2.4 - 185	4,200 - 23,000	495 - 3,200	6.89 - 8.93
Forging Scrubber Liquor	0.003	0.5	162	2	---
Solution Heat Treatment Contact Cooling	<0.010 - 5.2	<0.1 - 9	1.5 - 370	<1 - 240	7 - 9.6
Cleaning or Etching Bath	<0.010 - <30.00	0.300 - 70,000	<1 - 1,900	1.0 - 1,540	0.15 - 11.4
Cleaning or Etching Rinse	<0.01 - 410	<0.01 - 1,300	<1 - 490	<1 - 3,640	0.55 - 11.8
Cleaning or Etching Scrubber Liquor	---	5.1	13	12	8.1

ND = Not Detected.

Table IX-13

BPT MASS LIMITATIONS FOR THE FORGING SUBCATEGORY*

Forging - Core Waste Streams

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
		mg/kg (lb/million lbs) of aluminum forged	
118	Cadmium	0.017	0.007
119	Chromium	0.022	0.009
120	Copper	0.095	0.050
121	Cyanide	0.014	0.006
122	Lead	0.021	0.010
124	Nickel	0.096	0.063
125	Selenium	0.061	0.027
128	Zinc	0.073	0.030
	Aluminum	0.320	0.159
	Oil & Grease	0.996	0.598
	Total Suspended Solids	2.042	0.971
	pH	Within the range of 7.0 to 10.0 at all times.	

Forging - Scrubber Liquor

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
		mg/kg (lb/million lbs) of aluminum forged	
118	Cadmium	0.526	0.232
119	Chromium	0.681	0.278
120	Copper	2.939	1.547
121	Cyanide	0.449	0.186
122	Lead	0.650	0.310
124	Nickel	2.970	1.965
125	Selenium	1.903	0.851
128	Zinc	2.259	0.944
	Aluminum	9.947	4.950
	Oil & Grease	30.940	18.564
	Total Suspended Solids	63.427	30.167
	pH	Within the range of 7.0 to 10.0 at all times.	

*All pollutants shown in Table IX-13 are not regulated at BPT since there are no existing forgers who are direct dischargers.

Table IX-13 (Continued)

BPT MASS LIMITATIONS FOR THE FORGING SUBCATEGORY

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	2.620	1.156
119	Chromium	3.390	1.387
120	Copper	14.640	7.705
121	Cyanide	2.234	0.925
122	Lead	3.236	1.541
124	Nickel	14.794	9.785
125	Selenium	9.477	4.238
128	Zinc	11.249	4.700
	Aluminum	49.543	24.656
	Oil & Grease	154.100	92.460
	Total Suspended Solids	315.905	150.248
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide	0.052	0.021
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc	0.261	0.109
	Aluminum	1.151	0.573
	Oil & Grease	3.580	2.148
	Total Suspended Solids	7.339	3.491
	pH	Within the range of 7.0 to 10.0 at all times.	

Table IX-13 (Continued)

BPT MASS LIMITATIONS FOR THE FORGING SUBCATEGORY

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	4.730	2.087
119	Chromium	6.121	2.504
120	Copper	26.433	13.912
121	Cyanide	4.034	1.699
122	Lead	5.843	2.783
124	Nickel	26.711	17.668
125	Selenium	17.112	7.652
128	Zinc	20.312	8.486
	Aluminum	89.454	44.518
	Oil & Grease	278.240	166.944
	Total Suspended Solids	570.392	271.284
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	5.406	2.385
119	Chromium	6.996	2.862
120	Copper	30.210	15.900
121	Cyanide	4.611	1.908
122	Lead	6.678	3.180
124	Nickel	30.528	20.193
125	Selenium	19.557	8.745
128	Zinc	23.214	9.699
	Aluminum	102.237	50.880
	Oil & Grease	318.000	190.800
	Total Suspended Solids	651.900	310.050
	pH	Within the range of 7.0 to 10.0 at all times.	

Table IX-14

PRODUCTION OPERATIONS - DRAWING WITH NEAT OILS SUBCATEGORY

Operation	Waste Stream	Normalized BPT Discharge 1/kkg	Normalized BPT Discharge (gpt)	Production Normalizing Parameter
Core				
Drawing with neat oils	Spent oils	0	(0)	
Annealing	None	0	(0)	
Stationary casting	None	0	(0)	
Homogenizing	None	0	(0)	
Artificial aging	None	0	(0)	
Degreasing	Spent solvent	0	(0)	
Sawing	Spent lubricant	4.807	(1.153)	Mass of aluminum drawn with neat oils
Swaging	None	0	(0)	
Miscellaneous nondescript wastewater sources	Various	45	(10.80)	Mass of aluminum drawn with neat oils
	Total Core	49.807	(11.95)	
Ancillary				
Continous rod casting	Contact cooling water	1,555	(373.2)	Mass of rod cast by continuous method
	Spent lubricant	1.964	(0.471)	Mass of rod cast by continuous method
Solution heat treatment	Contact cooling water	7,705	(1,848)	Mass of aluminum quenched
Cleaning or etching	Bath	179	(42.96)	Mass of aluminum cleaned or etched
	Rinse	13,912	(3,339)	Mass of aluminum cleaned or etched
	Scrubber liquor	15,900	(3,816)	Mass of aluminum cleaned or etched

Table IX-15

CONCENTRATION RANGE OF POLLUTANTS CONSIDERED FOR BPT REGULATION IN CORE AND ANCILLARY WASTE STREAMS - DRAWING WITH NEAT OILS SUBCATEGORY

Waste Stream	Cadmium (mg/l)	Total Chromium (mg/l)	Copper (mg/l)	Total Cyanide (mg/l)	Lead (mg/l)	Nickel (mg/l)
Sawing Spent Lubricants	0.012 - 0.020	<0.020 - 0.160	0.100 - 1.250	<0.020	<0.100 - 0.500	<0.050 - 0.122
Continuous Rod Casting Contact Cooling[B]	<0.0005 - 0.020	<0.001 - 1.6	0.004 - 0.030	---	0.002 - 0.100	<0.001 - 0.020
Continuous Rod Casting Spent Lubricants[A]	<0.0002 - 0.180	<0.001 - 1	ND - 7.40	0.016 - 2.5	<0.002 - 56.90	<0.001 - 0.28
Solution Heat Treatment Contact Cooling	<0.001 - 0.012	0.002 - 72	0.001 - 0.38	<0.001 - 530	ND - 17	<0.001 - 0.040
Cleaning or Etching Bath	0.005 - 3.000	0.020 - 10.00	<0.05 - 20	<0.001 - 0.408	0.400 - 90.0	0.001 - 486
Cleaning or Etching Rinse	<0.0005 - 0.200	0.007 - 280	0.0011 - 480	0.00002 - 0.042	0.01 - 11	<0.001 - 160
Cleaning or Etching Scrubber Liquor	---	---	0.01	---	---	---

ND = Not Detected.

[A] This stream was assumed to be similar to Rolling with Emulsions Spent Emulsions.

[B] This stream was assumed to be similar to Direct Chill Casting Contact Cooling.

Table IX-15 (Continued)

CONCENTRATION RANGE OF POLLUTANTS CONSIDERED FOR BPT REGULATION IN CORE AND ANCILLARY WASTE STREAMS - DRAWING WITH NEAT OILS SUBCATEGORY

Waste Stream	Zinc (mg/l)	Aluminum (mg/l)	Oil and Grease (mg/l)	TSS (mg/l)	pH (units)
Sawing Spent Lubricants	0.180 - 12.9	2.4 - 185	4,200 - 23,000	495 - 3,200	6.89 - 8.93
Continuous Rod Casting Contact Cooling[B]	<0.010 - 1.0	<0.050 - 2	<5 - 236	<1 - 220	6 - 8.4
Continuous Rod Casting Spent Lubricants[A]	<0.005 - 16	20 - 350	1,277 - 802,000	0.540 - 3,910	6.9 - 9.74
Solution Heat Treatment Contact Cooling	<0.010 - 5.2	<0.1 - 9	1.5 - 370	<1 - 240	7 - 9.6
Cleaning or Etching Bath	<0.010 - <30.00	0.300 - 70,000	<1 - 1,900	1.0 - 1,540	0.15 - 11.4
Cleaning or Etching Rinse	<0.01 - 410	<0.01 - 1,300	<1 - 490	<1 - 3,640	0.55 - 11.8
Cleaning or Etching Scrubber Liquor	---	5.1	13	12	8.1

ND = Not Detected.

[A] This stream was assumed to be similar to Rolling with Emulsions Spent Emulsions.

[B] This stream was assumed to be similar to Direct Chill Casting Contact Cooling.

Table IX-16

BPT MASS LIMITATIONS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Drawing With Neat Oils - Core Waste Streams

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum drawn with neat oils		
118	Cadmium	0.017	0.007
119	Chromium*	0.022	0.009
120	Copper	0.097	0.050
121	Cyanide*	0.015	0.005
122	Lead	0.021	0.010
124	Nickel	0.096	0.063
125	Selenium	0.061	0.027
128	Zinc*	0.073	0.031
	Aluminum*	0.320	0.160
	Oil & Grease*	0.996	0.598
	Total Suspended Solids*	2.042	0.972
	pH*	Within the range of 7.0 to 10.0 at all times.	

Continuous Rod Casting - Contact Cooling Water

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118	Cadmium	0.529	0.233
119	Chromium*	0.684	0.28
120	Copper	2.955	1.555
121	Cyanide*	0.451	0.187
122	Lead	0.653	0.311
124	Nickel	2.986	1.975
125	Selenium	1.913	0.855
128	Zinc*	2.271	0.949
	Aluminum*	10.00	4.976
	Oil & Grease*	31.100	18.660
	Total Suspended Solids*	63.755	30.322
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-16 (Continued)

BPT MASS LIMITATIONS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Continuous Rod Casting - Spent Lubricant

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods			
118	Cadmium	0.0007	0.0003
119	Chromium*	0.0009	0.0004
120	Copper	0.0037	0.0020
121	Cyanide*	0.0006	0.0003
122	Lead	0.0008	0.0004
124	Nickel	0.0038	0.0025
125	Selenium	0.0024	0.0011
128	Zinc*	0.0029	0.0012
	Aluminum*	0.0126	0.0063
	Oil & Grease*	0.0393	0.0236
	Total Suspended Solids*	0.0805	0.0383
	pH*	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched			
118	Cadmium	2.620	1.156
119	Chromium*	3.390	1.387
120	Copper	14.640	7.705
121	Cyanide*	2.235	0.925
122	Lead	3.236	1.541
124	Nickel	14.794	9.785
125	Selenium	9.477	4.238
128	Zinc*	11.249	4.700
	Aluminum*	49.543	24.656
	Oil & Grease*	154.100	92.460
	Total Suspended Solids*	315.905	150.248
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-16 (Continued)

BPT MASS LIMITATIONS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
		mg/kg (lb/million lbs) of aluminum cleaned or etched	
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.261	0.109
	Aluminum*	1.150	0.573
	Oil & Grease*	3.580	2.148
	Total Suspended Solids*	7.339	3.491
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
		mg/kg (lb/million lbs) of aluminum cleaned or etched	
118	Cadmium	4.730	2.087
119	Chromium*	6.121	2.504
120	Copper	26.433	13.912
121	Cyanide*	4.034	1.669
122	Lead	5.843	2.783
124	Nickel	26.711	17.668
125	Selenium	17.112	7.652
128	Zinc*	20.312	8.486
	Aluminum*	89.454	44.518
	Oil & Grease*	278.240	166.944
	Total Suspended Solids*	570.392	271.284
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-16 (Continued)

BPT MASS LIMITATIONS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched		
118 Cadmium	5.406	2.385
119 Chromium*	6.996	2.862
120 Copper	30.210	15.900
121 Cyanide*	4.611	1.908
122 Lead	6.678	3.180
124 Nickel	30.528	20.193
125 Selenium	19.557	8.745
128 Zinc*	23.214	9.699
Aluminum*	102.237	50.880
Oil & Grease*	318.000	190.800
Total Suspended Solids*	651.900	310.050
pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-17

PRODUCTION OPERATIONS - DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Operation	Waste Stream	Normalized BPT Discharge 1/kkg	(gpt)	Production Normalizing Parameter
Core				
Drawing with emulsions or soaps	Spent lubricants	416.5	(99.89)	Mass of aluminum drawn with emulsions or soaps
Annealing	None	0	(0)	
Stationary casting	None	0	(0)	
Homogenizing	None	0	(0)	
Artificial aging	None	0	(0)	
Degreasing	Spent solvent	0	(0)	
Sawing	Spent lubricant	4.807	(1.153)	Mass of aluminum drawn with emulsions or soaps
Swaging	None	0	(0)	
Miscellaneous nondescript wastewater sources	Various	45	(10.80)	Mass of aluminum drawn with emulsions or soaps
	Total Core	466.3	(111.9)	
Ancillary				
Continuous rod casting	Contact cooling water	1,555	(373.2)	Mass of rod cast by continuous methods
	Spent lubricant	1.964	(0.471)	Mass of rod cast by continuous methods
Solution heat treatment	Contact cooling water	7,705	(1,848)	Mass of aluminum quenched
Cleaning or etching	Bath	179	(42.96)	Mass of aluminum cleaned or etched
	Rinse	13,912	(3,339)	Mass of aluminum cleaned or etched
	Scrubber liquor	15,900	(3,816)	Mass of aluminum cleaned or etched

Table IX-18

COMPARISON OF WASTEWATER DISCHARGE RATES FROM DRAWING EMULSION AND SOAP STREAMS

Plant Number	Wastewater (gal/ton)	Wastewater (l/kkg)	Order of Increasing Production	Lubricant Type	Product Type
1	0	0	8	Emulsion	Tube
2	0.8100	3.377	10	Emulsion	Wire
3	2.810	11.72	6	Emulsion	Wire
4	6.279	26.18	9	Emulsion	Wire
5	62.50	260.6	3	Emulsion	Wire
6	260.0	1,084	2	Soap	Wire
7	267.0	1,113	5	Emulsion	Wire
8	257,100	1,072,000	1	Soap	Wire
9	*	*	4	Emulsion	Wire
10	*	*	*	Emulsion	Wire
11	*	*	*	Emulsion	Wire
12	*	*	7	Soap and Emulsion	Wire
13	*	*	*	Soap	Wire

*Sufficient data not available to calculate these values.

Table IX-19

CONCENTRATION RANGE OF POLLUTANTS CONSIDERED FOR BPT REGULATION IN CORE AND ANCILLARY WASTE STREAMS - DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Waste Stream	Cadmium (mg/l)	Total Chromium (mg/l)	Copper (mg/l)	Total Cyanide (mg/l)	Lead (mg/l)	Nickel (mg/l)
Drawing Spent Emulsions or Soaps[A]	<0.0002 - 0.180	<0.001 - 1	ND - 7.40	0.016 - 2.5	<0.002 - 56.90	<0.001 - 0.28
Sawing Spent Lubricants	0.012 - 0.020	<0.020 - 0.160	0.100 - 1.250	<0.020	<0.100 - 0.500	<0.050 - 0.122
Continuous Rod Casting Contact Cooling[B]	<0.0005 - 0.020	<0.001 - 1.6	0.004 - 0.030	---	0.002 - 0.100	<0.001 - 0.020
Continuous Rod Casting Spent Lubricants[A]	<0.0002 - 0.180	<0.001 - 1	ND - 7.40	0.016 - 2.5	<0.002 - 56.90	<0.001 - 0.28
Solution Heat Treatment Contact Cooling	<0.0005 - 0.012	0.002 - 72	0.001 - 0.38	<0.001 - 530	ND - 17	<0.001 - 0.040
Cleaning or Etching Bath	0.005 - 3.000	0.020 - 10.00	<0.05 - 20	<0.001 - 0.408	0.400 - 90.0	0.001 - 486
Cleaning or Etching Rinse	<0.0005 - 0.200	0.007 - 280	0.0011 - 480	0.00002 - 0.042	0.01 - 11	<0.001 - 160
Cleaning or Etching Scrubber Liquor	---	---	0.01	---	---	---

ND = Not Detected.

[A] These streams were assumed to be similar to Rolling with Emulsions Spent Emulsions.

[B] This stream was assumed to be similar to Direct Chill Casting Contact Cooling.

Table IX-19 (Continued)

CONCENTRATION RANGE OF POLLUTANTS CONSIDERED FOR BPT REGULATION IN CORE AND ANCILLARY WASTE STREAMS - DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Waste Stream	Zinc (mg/l)	Aluminum (mg/l)	Oil and Grease (mg/l)	TSS (mg/l)	pH (units)
Drawing Spent Emulsions or Soaps[A]	<0.005 - 16	20 - 350	1,277 - 802,000	0.540 - 124,540	6.9 - 9.74
Sawing Spent Lubricants	0.180 - 12.9	2.4 - 185	4,200 - 23,000	495 - 3,200	6.89 - 8.93
Continuous Rod Casting Contact Cooling[B]	<0.010 - 1.0	<0.050 - 2	<5 - 236	<1 - 220	6 - 8.4
Continuous Rod Casting Spent Lubricants[A]	<0.005 - 16	20 - 350	1,277 - 802,000	0.540 - 3,910	6.9 - 9.74
Solution Heat Treatment Contact Cooling	<0.010 - 5.2	<0.1 - 9	1.5 - 370	<1 - 240	7 - 9.6
Cleaning or Etching Bath	<0.010 - <30.00	0.300 - 70,000	<1 - 1,900	1.0 - 1,540	0.15 - 11.4
Cleaning or Etching Rinse	<0.01 - 410	<0.01 - 1,300	<1 - 490	<1 - 3,640	0.55 - 11.8
Cleaning or Etching Scrubber Liquor	---	5.1	13	12	8.1

ND = Not Detected.

[A] These streams were assumed to be similar to Rolling with Emulsions Spent Emulsions.

[B] This stream was assumed to be similar to Direct Chill Casting Contact Cooling.

Table IX-20

BPT MASS LIMITATIONS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Drawing With Emulsions or Soaps - Core Waste Streams

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum drawn with emulsions or soaps		
118 Cadmium	0.159	0.070
119 Chromium*	0.205	0.084
120 Copper	0.886	0.466
121 Cyanide*	0.135	0.056
122 Lead	0.196	0.094
124 Nickel	0.895	0.592
125 Selenium	0.574	0.256
128 Zinc*	0.680	0.285
Aluminum*	2.998	1.492
Oil & Grease*	9.326	5.596
Total Suspended Solids*	19.118	9.093
pH*	Within the range of 7.0 to 10.0 at all times.	

Continuous Rod Casting - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.529	0.233
119 Chromium*	0.684	0.28
120 Copper	2.955	1.555
121 Cyanide*	0.450	0.187
122 Lead	0.653	0.311
124 Nickel	2.986	1.975
125 Selenium	1.913	0.855
128 Zinc*	2.270	0.949
Aluminum*	9.999	4.976
Oil & Grease*	31.100	18.660
Total Suspended Solids*	63.755	30.323
pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-20 (Continued)

BPT MASS LIMITATIONS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Continuous Rod Casting - Spent Lubricant

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.0007	0.0003
119 Chromium*	0.0009	0.0004
120 Copper	0.0037	0.0020
121 Cyanide*	0.0006	0.0003
122 Lead	0.0008	0.0004
124 Nickel	0.0038	0.0025
125 Selenium	0.0024	0.0011
128 Zinc*	0.0029	0.001
Aluminum*	0.0126	0.0063
Oil & Grease*	0.0393	0.0236
Total Suspended Solids*	0.0805	0.0390
pH*	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched		
118 Cadmium	2.620	1.156
119 Chromium*	3.390	1.387
120 Copper	14.640	7.705
121 Cyanide*	2.234	0.925
122 Lead	3.236	1.541
124 Nickel	14.794	9.785
125 Selenium	9.477	4.238
128 Zinc*	11.249	4.700
Aluminum*	49.549	24.656
Oil & Grease*	154.100	92.460
Total Suspended Solids*	315.905	150.248
pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-20 (Continued)

BPT MASS LIMITATIONS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched			
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.262	0.109
	Aluminum*	1.151	0.573
	Oil & Grease*	3.580	2.148
	Total Suspended Solids*	7.339	3.491
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched			
118	Cadmium	4.730	2.087
119	Chromium*	6.121	2.504
120	Copper	26.433	13.912
121	Cyanide*	4.034	1.669
122	Lead	5.843	2.783
124	Nickel	26.711	17.668
125	Selenium	17.112	7.652
128	Zinc*	20.312	8.486
	Aluminum*	89.454	44.519
	Oil & Grease*	278.240	166.944
	Total Suspended Solids*	570.392	271.284
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-20 (Continued)

BPT MASS LIMITATIONS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	5.406	2.385
119	Chromium*	6.996	2.862
120	Copper	30.210	15.900
121	Cyanide*	4.611	1.908
122	Lead	6.678	3.180
124	Nickel	30.528	20.193
125	Selenium	19.557	8.745
128	Zinc*	23.214	9.699
	Aluminum*	102.237	50.880
	Oil & Grease*	318.000	190.800
	Total Suspended Solids*	651.900	310.050
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table IX-21

ALLOWABLE DISCHARGE CALCULATIONS FOR PLANT X IN EXAMPLE 1

Waste Stream	Average Daily Production (kkg/day)	BPT Regulatory One-Day Maximum TSS Discharge (mg/kg)*	BPT Regulatory 10-Day Average TSS Discharge (mg/kg)*	BPT Allowable One-Day Maximum TSS Discharge (mg/day)	BPT Allowable 10-Day Average TSS Discharge (mg/day)
Extrusion Core	200	15.0	7.13	3,000,000	1,426,000
Direct Chill Casting Contact Cooling Water	200	54.49	25.92	10,898,000	5,184,000
Degassing Scrubber Liquor	200	106.97	50.88	21,394,000	10,176,000
Solution Heat Treatment Contact Cooling Water	140	315.9	150.25	44,226,000	21,035,000
Etch Line Bath	100	7.34	3.49	734,000	349,000
Etch Line Rinse	100	570.4	271.3	57,040,000	27,130,000
Total				137,290,000** or 137.3 kg/day	65,299,000** or 65.3 kg/day

*These values are taken from Table IX-10.

**Allowable discharge concentrations (mg/l) can be calculated by dividing these values by the plant's daily process water discharge (liters).

Table IX-22

ALLOWABLE DISCHARGE CALCULATIONS FOR PLANT Y IN EXAMPLE 2

Waste Stream	Average Daily Production (kkg/day)	BPT Regulatory One-Day Maximum Zn Discharge (mg/kg)*	BPT Regulatory 10-Day Average Zn Discharge (mg/kg)*	BPT Allowable One-Day Maximum Zn Discharge (mg/day)	BPT Allowable 10-Day Average Zn Discharge (mg/day)
Rolling with Emulsions Core	66.6	0.190	0.08	12,650	5,330
Drawing with Emulsions or Soaps Core	6.7	0.681	0.285	4,560	1,910
Direct Chill Casting Contact Cooling Water	33.3	1.94	0.811	64,600	27,000
Continuous Rod Casting Contact Cooling Water	6.7	2.27	0.949	15,210	6,360
Continuous Rod Casting Spent Lubricant	6.7	0.0029	0.0012	230	8,040
Solution Heat Treatment Contact Cooling Water	23.3	11.25	4.70	262,130	109,510
Etch Line Bath	20.6	0.262	0.109	5,400	2,250
Etch Line Rinse	20.6	20.31	8.49	418,390	174,890
Total				802,170** or 0.8 kg/day	335,290** or 0.34 kg/day

*These values are taken from Table IX-7 and Table IX-20.

**Allowable discharge concentrations (mg/l) can be calculated by dividing these values by the plant's daily process water discharge (liters).

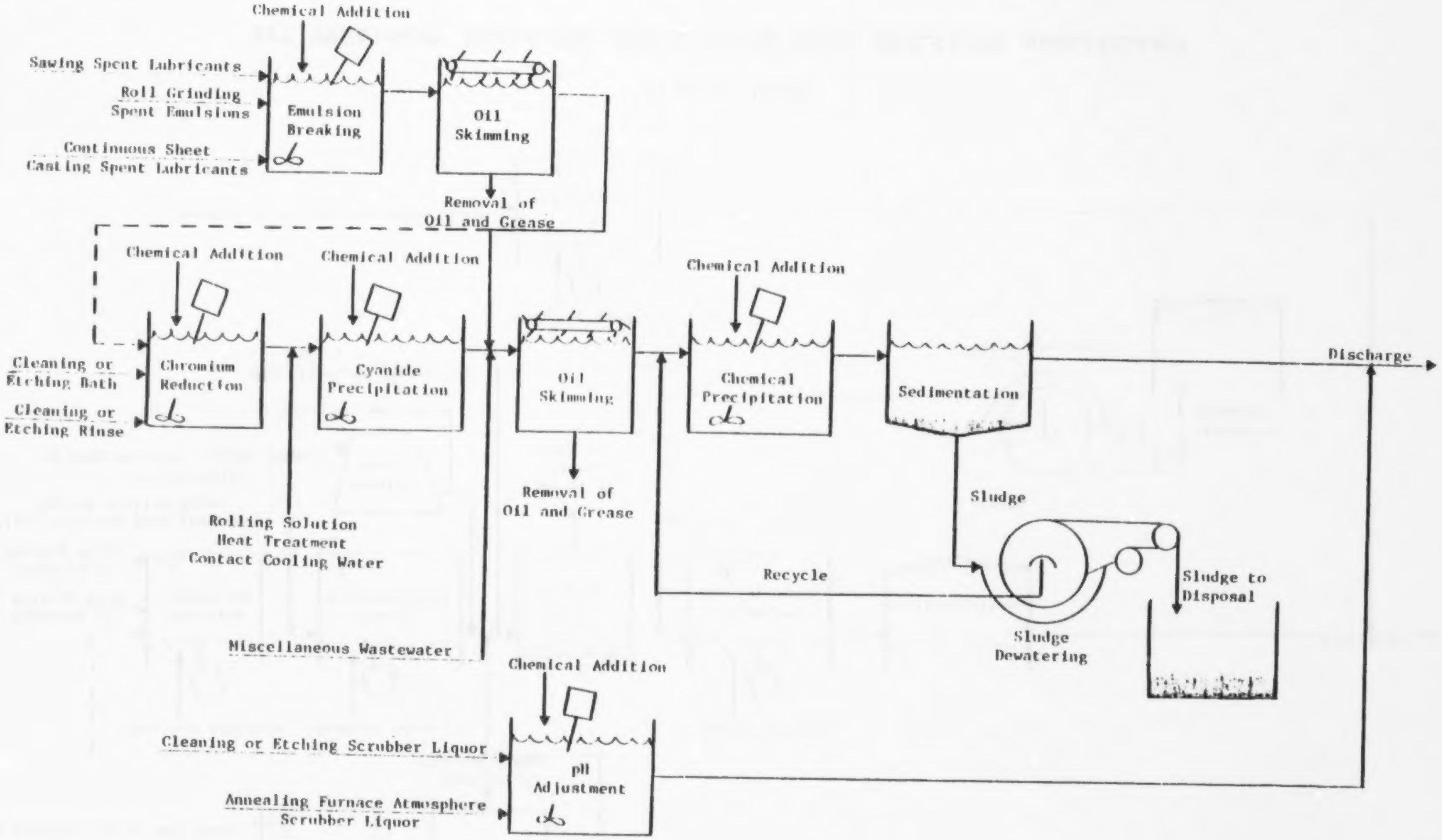

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Figure IX-1

BPT TREATMENT TRAIN FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

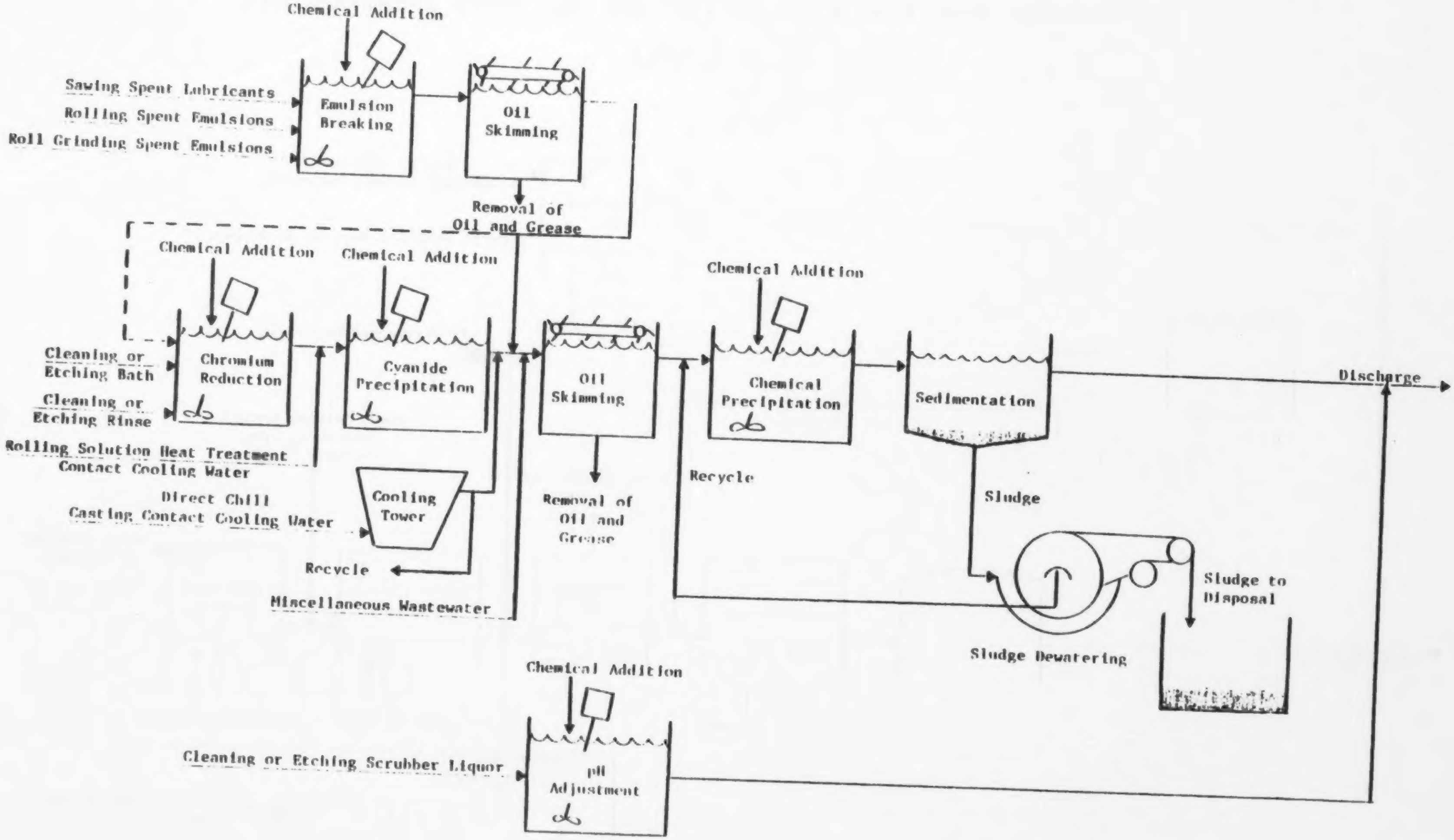

Figure IX-2

BPT TREATMENT TRAIN FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

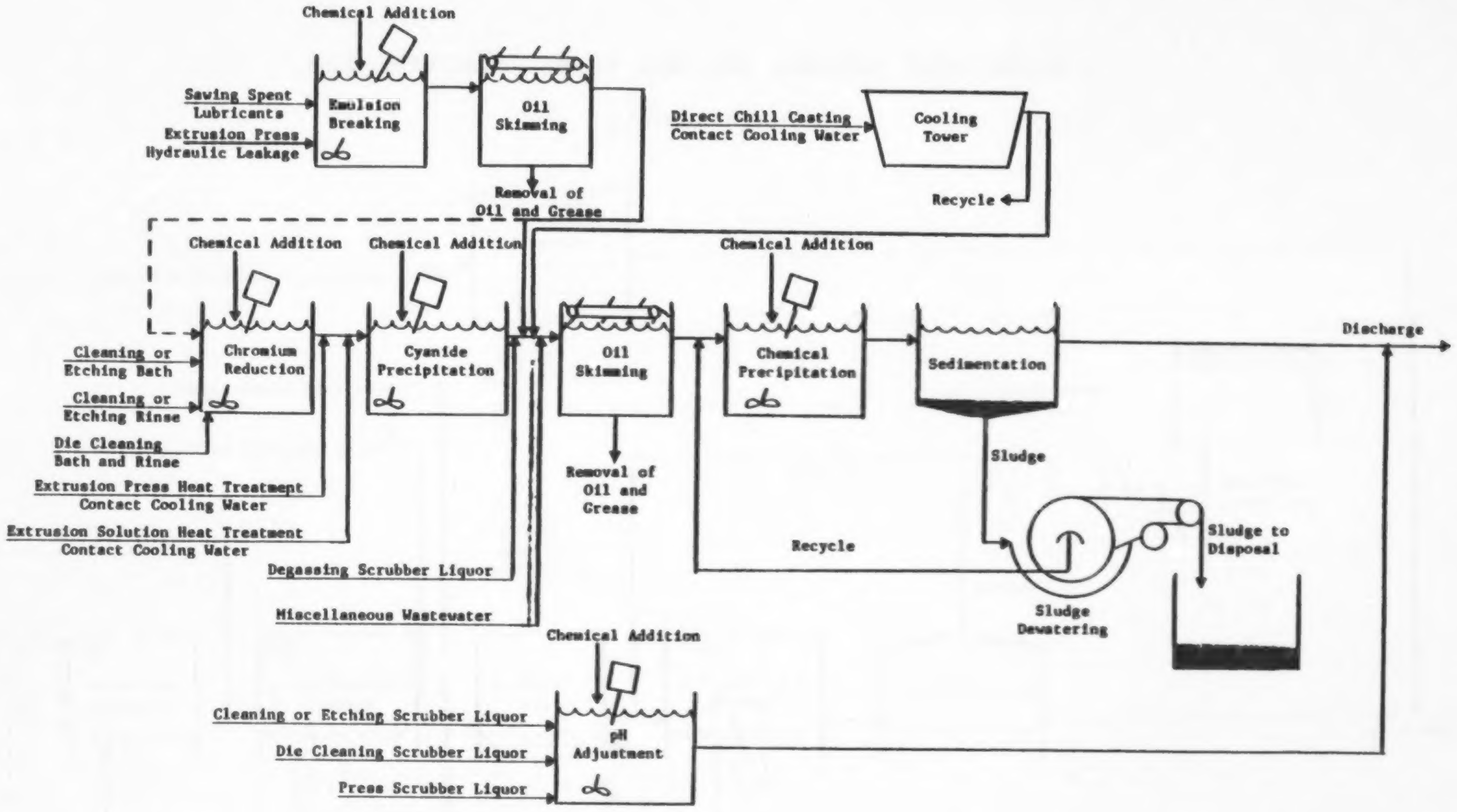

Figure IX-3

BPT TREATMENT TRAIN FOR THE EXTRUSION SUBCATEGORY

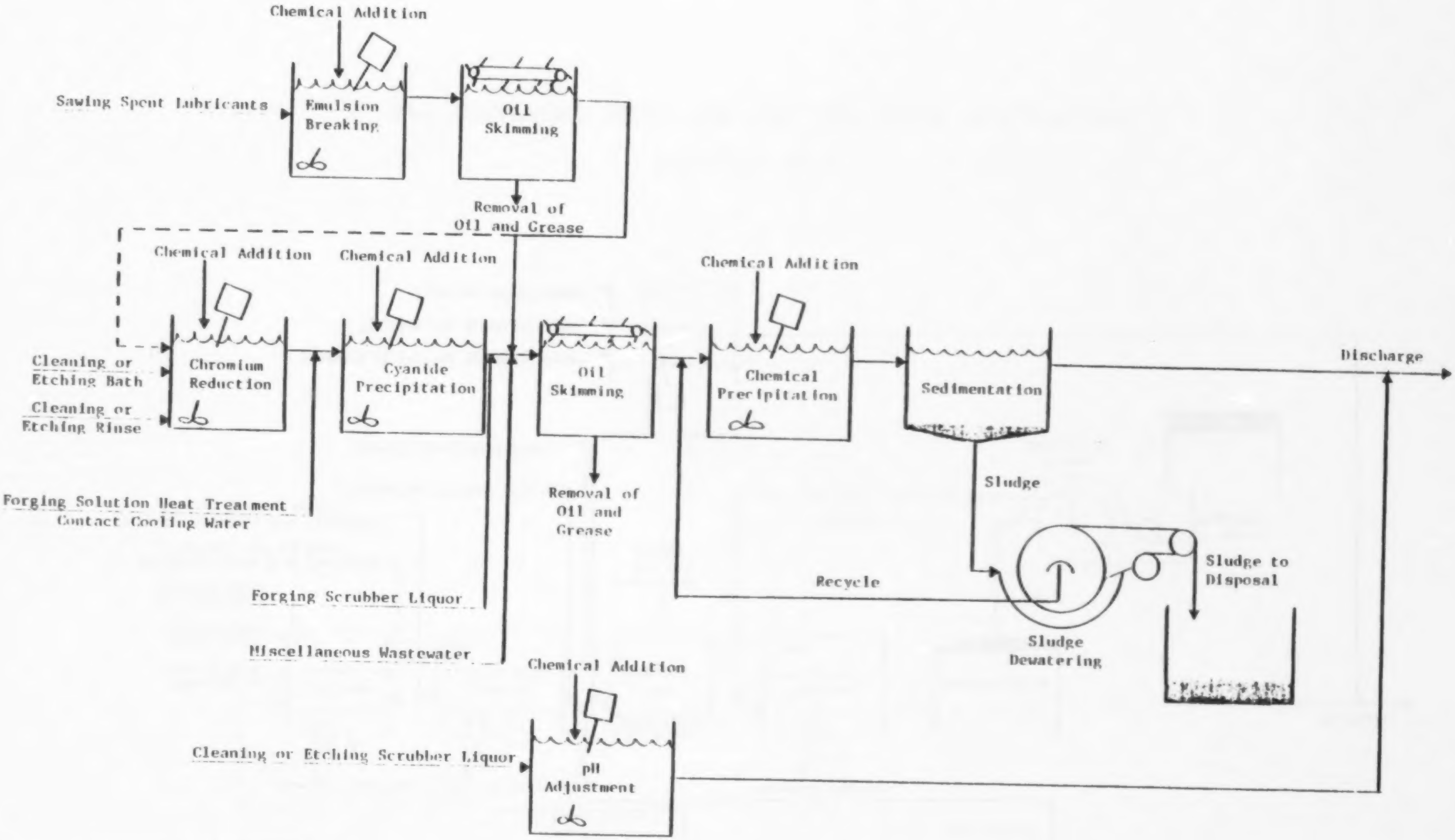

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Figure IX-4

BPT TREATMENT TRAIN FOR THE FORGING SUBCATEGORY

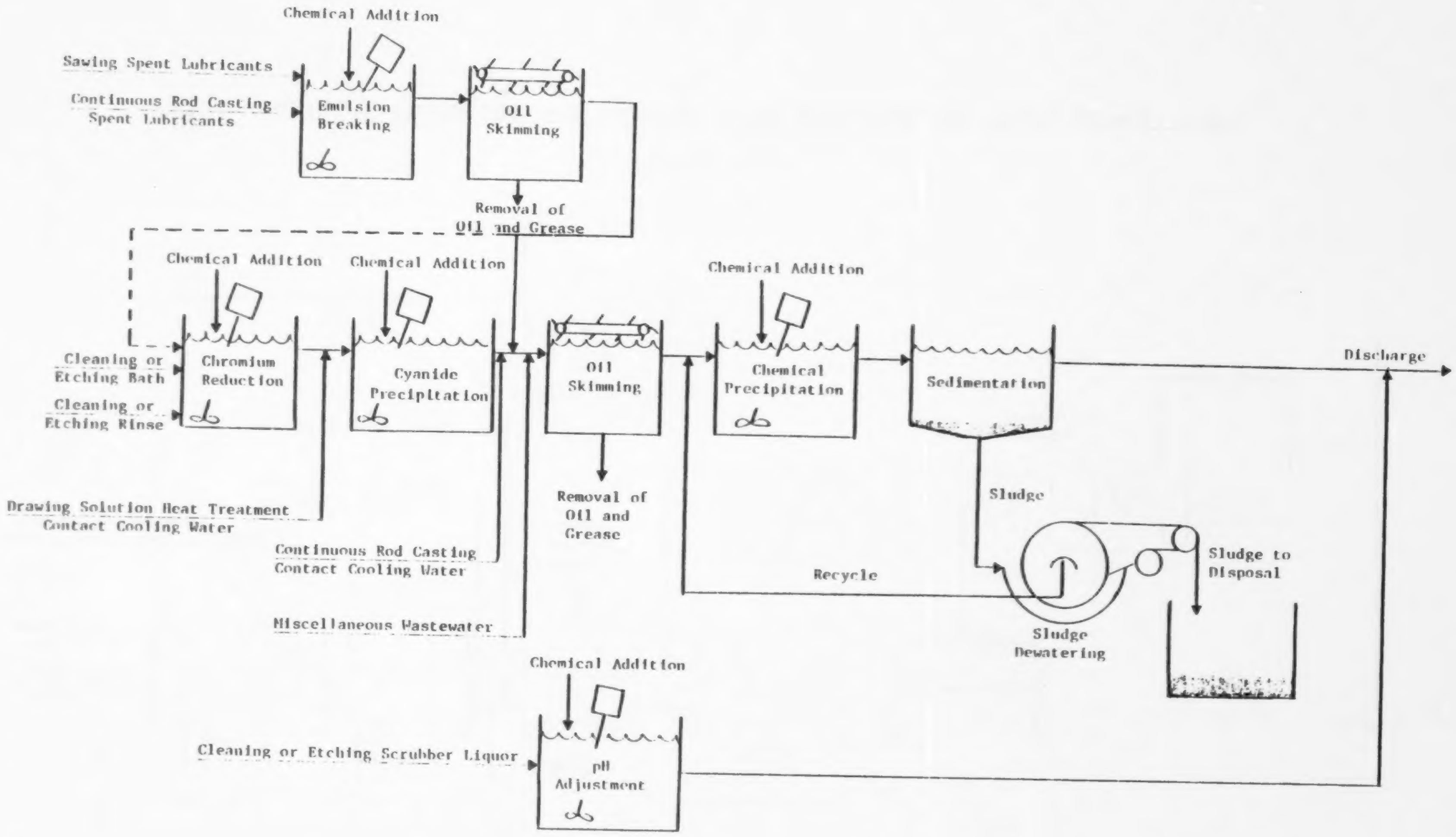

Figure IX-5

BPT TREATMENT TRAIN FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

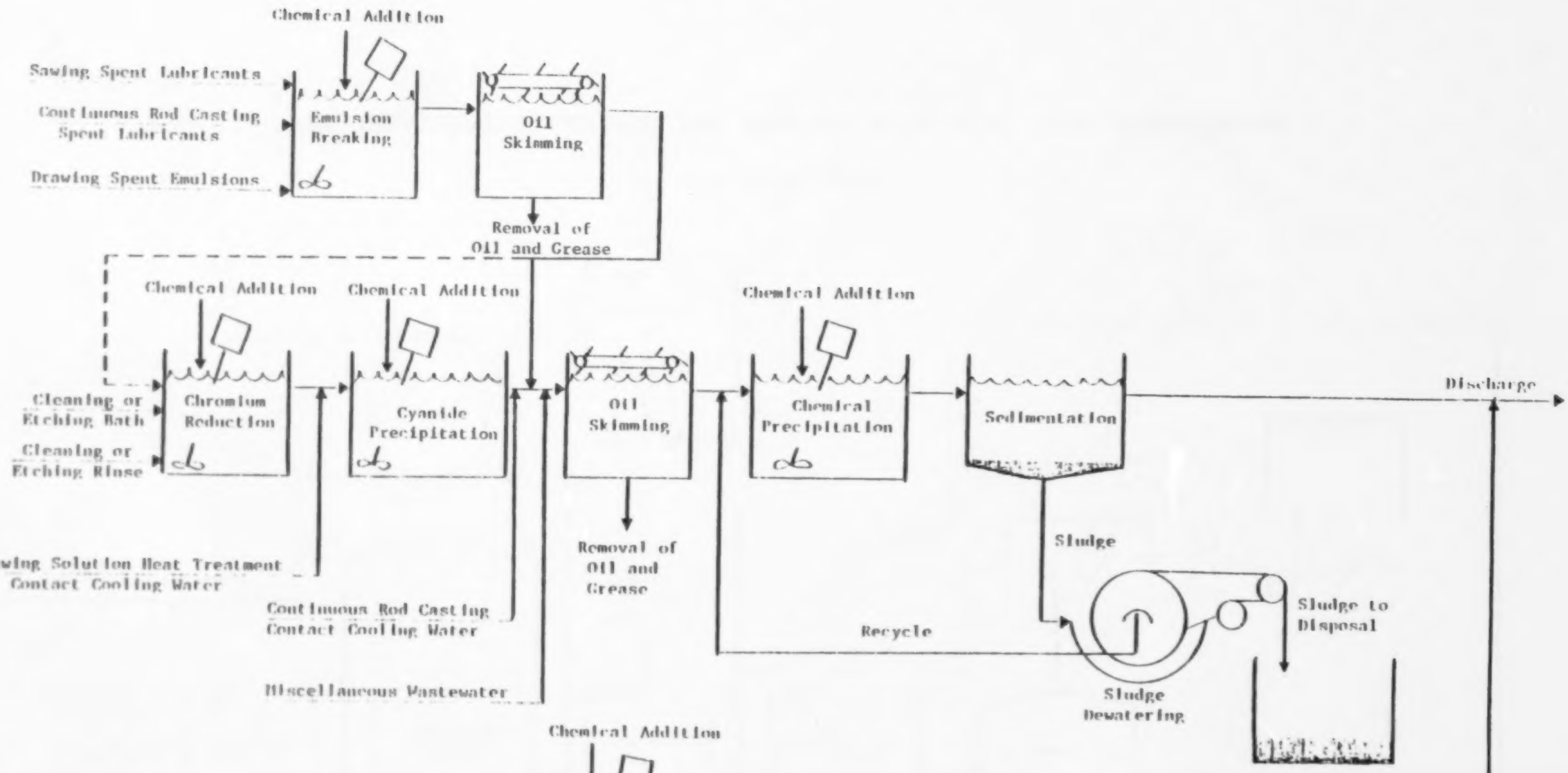

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Figure IX-6

BPT TREATMENT TRAIN FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

SECTION X

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

The effluent limitations in this section apply to existing direct dischargers. A direct discharger is a facility which discharges or may discharge pollutants into waters of the United States. These effluent limitations, which must be achieved by July 1, 1984, are based on the best control and treatment technology employed by a specific point source within the industrial category or subcategory, or by another industry where it is readily transferable. Emphasis is placed on additional treatment techniques applied at the end of the treatment systems currently employed for BPT, as well as improvements in reagent control, process control, and treatment technology optimization.

The factors considered in assessing best available technology economically achievable (BAT) include the age of equipment and facilities involved, the process employed, process changes, non-water quality environmental impacts (including energy requirements), and the costs of application of such technology. BAT technology represents the best existing economically achievable performance of plants of various ages, sizes, processes, or other characteristics. Those categories whose existing performance is uniformly inadequate may require a transfer of BAT from a different subcategory or category. BAT may include process changes or internal controls, even when these are not common industry practice. This level of technology also considers those plant processes and control and treatment technologies which at pilot plant and other levels have demonstrated both technological performance and economic viability at a level sufficient to justify investigation.

TECHNICAL APPROACH TO BAT

The Agency reviewed a wide range of technology options and evaluated the available possibilities to ensure that the most effective and beneficial technologies were used as the basis of BAT. To accomplish this, the Agency elected to examine at least three significant technology alternatives which could be applied to aluminum forming as BAT options and which would represent substantial progress toward prevention of polluting the environment above and beyond progress achievable by BPT. The statutory assessment of BAT considers costs, but does not require a balancing of costs against effluent reduction benefits see Weyerhaeuser v. Costle, 11 ERC 2149 (D.C. Cir. 1978); however, in assessing the proposed BAT, the Agency has given substantial weight to the reasonableness of costs.

EPA evaluated six levels of BAT for the category at proposal. Option 1 is BPT treatment. Option 2 is BPT treatment plus flow reduction and in-plant controls. Options 3, 4, 5, and 6 provide additional levels of treatment. Options 1, 2, 3, 4, and 5 technologies are, in general, equally applicable to all the subcategories of the aluminum forming category, while Option 6 is applicable to one subcategory (forging). Eacn treatment option produces similar concentrations of pollutants in the the effluent from all subcategories. Mass limitations derived from these options may vary; however, because of the impact of different production normalized wastewater discharge flow allowances.

Options 1, 2, and 3 are based on the chemical emulsion breaking technology from the BPT technology train, whereas Options 4, 5, and 6 are based on thermal emulsion breaking.

In summary form, the treatment technologies which were considered for aluminum forming are:

Option 1 (Figure X-1) is based on:

Oil skimming,

Lime and settle (chemical precipitation of metals followed by sedimentation), and

pH adjustment; and, where required,

Cyanide removal,

Hexavalent chromium reduction, and

Chemical emulsion breaking.

(This option is equivalent to the technology on which BPT is based.)

Option 2 (Figure X-2) is based on:

Option 1, plus process wastewater flow reduction by the following methods:

- Heat treatment contact cooling water recycle through cooling towers.
- Continuous rod casting contact cooling water recycle.
- Air pollution control scrubber liquor recycle.
- Countercurrent cascade rinsing or other water efficient methods applied to cleaning or etching and extrusion die cleaning rinses.

- Regeneration or contract hauling of cleaning or etching baths (proposed but not promulgated)
- Use of extrusion die cleaning rinse for bath make-up water
- Alternative fluxing or in-line refining methods, neither of which require wet air pollution control, for degassing aluminum melts.

Option 3 (Figure X-3) is based on:

Option 2, plus multimedia filtration at the end of the Option 2 treatment train.

Option 4 (Figure X-4) is based on:

Option 1 plus process wastewater flow reduction by the following methods:

- Thermal emulsion breaking or contractor hauling for concentrated emulsions.
- Heat treatment contact cooling water recycle through cooling towers.
- Continuous rod casting contact cooling water recycle.
- Air pollution control scrubber liquor recycle.
- Hauling or regeneration of spent cleaning or etching baths.
- Countercurrent cascade rinsing or other water efficient methods applied to cleaning or etching and extrusion die cleaning rinses.
- Alternative fluxing or in-line refining methods, which do not require wet air pollution control, for degassing aluminum melts.

Option 5 (Figure X-5) is based on:

Option 4, plus multimedia filtration at the end of the Option 4 treatment train.

Option 6 (Figure X-6) is based on:

Option 5, plus granular activated carbon treatment as a preliminary treatment step to remove toxic organics.

Option 1

Option 1 represents the BPT end-of-pipe treatment technology. This treatment train consists of preliminary treatment when necessary of emulsion breaking and skimming, hexavalent chromium reduction, and cyanide removal. The effluent from preliminary treatment is combined with other wastewaters for central treatment by skimming and lime and settle.

Option 2

Option 2 builds upon the BPT end-of-pipe treatment technologies of skimming, lime and settle with preliminary treatment to reduce chromium, remove cyanide and break emulsions. Flow reduction measures, based on in-process changes, are the mechanisms for reducing pollutant discharges at Option 2. Flow reduction measures eliminate some wastewater streams and concentrate the pollutants in others. Treatment of a more concentrated stream allows a greater net removal of pollutants and economies of treating a reduced flow. Methods for reducing process wastewater generation or discharge include:

Heat Treatment Contact Cooling Water Recycle Through Cooling Towers. The cooling and recycle of heat treatment contact cooling water is practiced by 15 plants. The function of heat treatment contact cooling water is to remove heat quickly from the aluminum. Therefore, the principal requirements of the water are that it be cool and not contain dissolved solids at a level that would cause water marks or other surface imperfections. There is sufficient industry experience to assure the success of this technology using cooling towers or heat exchangers. Although four plants have reported that they do not discharge any quench water by reason of continued recycle, some blowdown or periodic cleaning is likely to be needed to prevent a build-up of dissolved and suspened solids.

Scrubber Liquor Reycle. The recycle of scrubber liquor from cleaning or etching process baths is practiced by two plants, on forging scrubbers at two plants, and by one plant for its annealing scrubber. The srubber water picks up particulates and fumes from the air. Scubbers have relatively low water quality requirements for effcient operation, accordingly, recycle of scrubber liquor isappropriate for aluminum forming operations. A blowdown or periodc cleaning is necessary to prevent the buildup of dissolvedand suspended solids.

Countercurrent Cascae Rinsing Applied to Cleaning or Etching and Die Cleaning Rinse. Countercurrent cascade rinsing is a mechanism commonly ecountered in aluminum forming, electroplating, and other metal processing operations (Section VII, p.). The cleanest water is used for final rinsing of an item, preceded by rinse stages usig water with progressively more contaminants to partially rinse the item. Fresh make-up water is added to the final rinse, and conaminated rinse water is discharged from the initial rinse stage. The make-up water for all but the final rinse stage is from the following stage.

The countercurrent cascade rinsing process substantially improves efficiencies of water use for rinsing. For example, the use of a two-stage countercurrent cascade rinse can reduce water usage to approximately one-tenth of that needed for a single-stage rinse to achieve the same level of product cleanliness. Similarly, a three-stage countercurrent cascade rinse would reduce water usage to approximately one-thirtieth. Countercurrent cascade rinsing is practiced at least four aluminum forming plants. In addition, although not strictly countercurrent cascade rinsing, two plants reuse the rinse water following one cleaning or etching bath for the rinse of a preceding bath. The installation of countercurrent cascade rinsing is applicable to existing aluminum forming plants in that the cleaning and etch operations are usually discrete operations and space is generally available for additional rinse tanks following these operations.

Alternative Fluxing Methods. There are a number of alternatives available to replace systems requiring wet scrubbers for degassing operations (melting furnace air pollution control). Among the alternatives are fluxes not requiring wet air pollution control and in-line refining methods that eliminate the need for fluxing. All aluminum forming plants but one have adopted the alternative fluxing methods and thereby eliminated their scrubbers.

If enough metal refining is taking place that large amounts of gases are being emitted and a wet scrubber is necessary, this is considered metal manufacturing and is covered under the aluminum subcategories of the nonferrous metals manufacturing point source category.

Regeneration or Contract Hauling of Cleaning or Etching Baths. The Agency proposed a zero discharge allowance for cleaning or etching baths based on regeneration or contract hauling of the baths. The Agency has reevaluated the basis of the zero discharge allowance and is establishing a flow allowance for this waste stream. New information and comments submitted on the proposed rule indicated that regeneration is not a fully developed technology applicable to all facilities in the category. Further, contract hauling produces no environmental benefit since these wastes are generally hauled to an off-site waste treatment facility which would treat them in much the same manner as they would be treated at the aluminum forming plant.

Option 3

Option 3 builds upon the technical requirements of Option 2 by adding conventional mixed-media filtration after the Option 2 technology train and the in-process flow reduction controls. There are two aluminum forming plants which presently treat wastewaters with a polishing filter. Option 3 differs from Option 5 only in the type of emulsion treatment it is based on. Option 3 is based on the chemical emulsion breaking technology, which does not achieve zero discharge.

Option 4

Option 4 builds upon the technologies established for Option 2. Thermal emulsion breaking is the principal mechanism for reducing pollutant discharges at Option 4.

Thermal Emulsion Breaking or Contractor Hauling to Achieve Zero Discharge of Concentrated Emulsions. The Agency has noted that recycle or contractor hauling of several waste streams (e.g., continuous rod casting lubricant, rolling emulsions, roll grinding emulsions, drawing emulsions, and saw oils) are common practices. Organics were found to be constituents of these wastes. Contractor hauling eliminated potential wastewater discharges, obviated the need for organics removal (granular activated carbon), and was the most cost-effective approach for many plants. It was, therefore, the method suggested and included in the cost estimate for many of these waste streams when small volumes were considered.

Thermal emulsion breaking also eliminates any discharge from the concentrated emulsion waste streams by concentrating the oil and distilling the water. The water can then be reused in the process. EPA is aware of one application of thermal emulsion breaking in this category. In addition, it is being used at four copper forming plants to treat their emulsified lubricants. The processes performed and lubricants used in copper forming are similar to those in aluminum forming, and as such the thermal emulsion breaking technology is applicable to the aluminum forming concentrated emulsion waste streams.

Thermal emulsion breaking does not eliminate contractor hauling of spent lubricants, but it does reduce the volume of waste to be disposed of, an important consideration in the face of the rising disposal costs.

Two aluminum forming plants reported achieving zero discharge of their emulsified wastes through treatment. One plant treats their emulsion with chemical emulsion breaking, followed by ultrafiltration, with the concentrate being recycled back through chemical emulsion breaking, and the filtrate is clarified and reused elsewhere in the plant. The second plant applies gravity separation to their emulsions and skims the oil, which is further processed and used as fuel. The water fraction, which still contains 0.1 percent oil, is sprayed onto a field.

Option 5

Option 5 builds upon the technical requirements of Option 4 by adding conventional mixed-media filtration. The filter suggested is of the gravity, mixed-media type, although other filters, such as rapid sand or pressure filters would perform equally well.

Option 6

Option 6 builds upon the technical requirements of Option 5. Option 6 complements the other technologies by applying granular activated carbon (GAC) to waste streams for which toxic organics were selected. By applying granular activated carbon as a preliminary treatment step rather than end-of-pipe treatment for waste streams where organics were found at significant levels, treatment efficiency is improved, and total treatment costs are reduced.

The Agency considered options 2 through 6 for BAT technology. Options 4 and 5 were rejected before proposal because of the extremely high energy requirements and costs associated with retrofitting thermal emulsion breaking technology into existing aluminum forming plants. Option 6 was also eliminated from consideration early in the decision process because of the high cost associated with its application and the minimal incremental removals of toxic organics achieved.

The Agency proposed BAT limitations based on Option 2 and stated that it would give equivalent consideration to Option 3, which is Option 2 with end-of-pipe polishing filtration added.

Industry Cost and Environmental Benefits of the Various Treatment Options

As a means of evaluating the economic achievability of each of these options, the Agency developed estimates of the compliance costs and benefits for Options 2 and 3. An estimate of capital and annual costs for BAT options 2 and 3 was prepared for each subcategory as an aid in choosing best BAT model technology. The cost estimates for the total subcategory are presented in Table X-1. Plant-by-plant cost estimates were made for 49 of 59 direct dischargers and extrapolated to the remaining direct dischargers in the category. These estimates are presented in Table X-2. All costs are based on 1982 dollars.

The cost methodology has been described in detail in Section VIII. Standard cost literature sources and vendor quotes were used for module capital and annual costs. Data from several sources were combined to yield average or typical equipment costs as a function of flow or other wastewater characteristics and design parameters. The resulting costs for individual pieces of equipment were combined to yield module costs. The cost data were coupled with specific flow data from each plant to establish system costs for each plant.

The total costs presented in Tables X-1 and X-2 represent estimates which were revised after proposal to consider plants which reported discharge flow from anodizing and conversion coating operations, and the treatment technology required for those wastewater streams which were not considered to be in-scope waste streams when the original cost estimates were prepared. In addition, the preproposal annual cost estimates were adjusted by subtracting 10 percent of the capital cost from the annual cost. This was done because an error in the original costing methodology doublecounted the value for depreciation.

Pollutant reduction benefit estimates were calculated for each option for each subcategory. The benefits that the treatment technologies can achieve are presented in Tables X-3 through X-8. The benefits that the treatment technologies will achieve for direct dischargers are presented in Tables X-9 through X-13. The benefits that the treatment technologies can achieve for a "normal plant" in each subcategory are presented in Tables X-14 through X-19. The characteristics of the normal plants are presented in Section VIII (p. 897).

The first step in the calculation of the benefit estimates is the calculation of production normalized raw waste values (mg/kkg) for each pollutant in each waste stream. These values, along with raw waste concentrations, are presented in Tables X-20 through X-25. raw waste values were calculated using one of three methods. When analytical concentration data (mg/l) and sampled production normalized flow values (l/kkg) were available for a given waste stream, individual raw waste values for each sample were calculated and averaged. This method allows for the retention of any relationship between concentration, flow, and production. When sampled production normalized flows were not available for a given waste stream, an average concentration was calculated for each pollutant, and the average raw waste normalized flow taken from the dcp information for that waste stream was used to calculate the raw waste. When no analytical values were available for a given waste stream, the raw waste values for a stream of similar water quality was used. The raw waste concentrations (mg/l) in Tables X-20 through X-25 were calculated by dividing the raw waste values (mg/kkg) by the average raw waste production normalized flow (l/kkg).

The total flow (l/yr) for each option for each subcategory was calculated by summing individual flow values for each waste stream in the subcategory for each option. The individual flow values were calculated by multiplying the total production associated with each waste stream in each subcategory (kkg/yr) by the appropriate production normalized flow (l/kkg) for each waste stream for each option.

The raw waste mass values (kg/yr) for each pollutant in each subcategory were calculated by summing individual raw waste masses for each waste stream in the subcategory. The individual raw waste mass values were calculated by multiplying the total production associated with each waste stream in each subcategory (kkg/yr) by the raw waste value (mg/kkg) for each pollutant in each waste stream.

The mass discharged (kg/yr) for each pollutant for each option for each subcategory was calculated by multiplying the total flow (l/yr) for those waste streams which enter the treatment system, by the treatment effectiveness concentration (mg/l) (Table VII-20, p. 807) for each pollutant for the appropriate option.

The total mass removed (kg/yr) for each pollutant for each option for each subcategory was calculated by subtracting the total mass discharged (kg/yr) from the total raw mass (kg/yr).

Total treatment performance values for each subcategory were calculated by using the total production (kkg/yr) of all plants in the subcategory for each waste stream. Treatment performance values for direct dischargers in each subcategory were calculated by using the total production (kkg/yr) of all direct dischargers in the subcategory for each waste stream. Treatment performance values for "normal plants" in each subcategory were calculated by the same method described above, based on normal plant productions and flows.

SELECTED OPTION FOR BAT

The Agency evaluated the compliance costs and benefits for Options 2 and 3 presented in Tables X-1 through X-19 to select a final option as BAT. Both of the options (2 and 3) provided additional pollutant reduction beyond that provided by BPT.

EPA has selected Option 2 as the basis for BAT effluent limitations. This option was selected because it provides protection of the environment consistent with proven operation of in-process controls and treatment effectiveness. The reduction of pollutants in the effluent, especially toxic metals, is substantial and economically achievable thus resulting in a minimal impact on the industry.

Option 2 builds upon the technologies established for BPT. Flow reduction measures are the principal mechanisms for reducing pollutant discharges at Option 2. Flow reduction measures result in eliminating some wastewater streams and concentrating the pollutants in others. Treatment of a more concentrated stream allows a greater net removal of pollutants and may reduce the cost of treatment by reducing the flow and hence the size of the treatment equipment.

All of the flow reduction technologies or control methods are presently employed in at least one aluminum forming plant. The application of technologies such as countercurrent cascade rinsing to cleaning or etching lines is not expected to cause serious interruptions in production since these operations tend to be used during one shift each day, five days per week allowing preliminary changes to be scheduled.

The Agency has decided not to include filtration as part of the model BAT treatment technology. EPA estimates that 29,000 kg/yr (64,000 lb/yr) of toxic metal pollutants will be discharged after the installation of BPT treatment technology; the model BAT treatment technology is estimated to remove an additional 15,000 kg/yr (33,000 lb) of toxic metals. The addition of filtration would remove approximately 4,300 kg/yr (9,500 lb/yr) of toxic pollutants discharged after BAT or a total removal of 94 percent of the total current discharge. This additional removal of 4,300 kg/yr achieved by filtration is equal to an additional removal of approximately 1 kg (2.2 lb) of toxic pollutants per day per discharger. The incremental costs of these effluent reductions are $8.2 million in capital cost and $2.5 million in total annual costs for all direct dischargers. In addition, 18 aluminum forming plants also perform coil coating. The Agency has structured the aluminum forming regulation and coil coating regulation to allow cotreatment of wastewaters at integrated facilities. The BAT limitations for the coil coating category are based on technology not including filtration. Establishing aluminum forming limitations based on polishing filters would have the effect of requiring such integrated facilities to install polishing filters. The Agency believes that given all of these factors, the costs involved do not warrant selection of filtration as a part of the BAT model treatment technology.

REGULATED POLLUTANT PARAMETERS

The raw wastewater concentrations from individual operations and the subcategory as a whole were examined to select those pollutant parameters found at frequencies and concentrations warranting regulation. Several toxic metals and aluminum were selected for regulation in each subcategory.

Many of the toxic organic compounds were detected above their level of quantification in wastewaters containing oils or oil emulsions. Organic compounds are known to be insoluble or slightly soluble in water and highly soluble in oil and, as a result of the normal mixing processes during wastewater treatment, equilibrium distribution of pollutants between the wastewater and oil should occur readily. Then by applying oil removal processes (i.e., oil-water separation or emulsion breaking), the organic pollutant levels are reduced.

The laboratory procedure of extracting a compound from organic and aqueous phases is analogous to the removal of nonpolar organic pollutants by oil skimming during wastewater treatment. Work on extraction of toxic organic pollutants, using the hydrocarbon solvent hexane, has demonstrated extractions ranging from 88 to 97 percent for polynuclear aromatic hydrocarbons when using a one-part hexane to 00-parts wastewater matrix. Addition of ionizable inorganic compounds enhances the extraction of pollutants by hexane. Equilibrium distribution of the pollutants is achieved by two minutes of shaking.

Extraction of pollutants by oil removal treatment processes varies in effectivenes with the relative solubilities of the pollutant. The chemical nature of the process produces a pollutant concentration inthe effluent (water), which is a function of the influent (oil and water) concentration of the pollutant. In some cases, the water resulting from the oil treatment process contains organics at oncentration levels which are treatable by GAC.

For aluminum forming wastewaters, effective oil removal technology (such as oil skimmng or emulsion breaking) is capable of removing approximatel 97 percent of the total toxic organics (TTO) from the raw wase. As shown in Table X-26, the achievable TTO concentration is aproximately 0.69 mg/l. The influent and effluent concentratios presented for each pollutant were taken from the data presente in Section V for several plants with effective oil removaltechnologies in place. In calculating the concentrations, if onl one day's sampling datum was available, that value was used;if two day's sampling data were available, the higher of the value was used; and, if three day's sampling data were available, the mean or the median value was used, whichever was higher. The Agency assumes that the 0.69 mg/l value is an appropriat basis for effluent limitations, since the highest values were ued in the calculation.

In addition to the pollutants listed in Table X-26, several other toxic organic pollutants are considered. These include p-chloro-m-cresol (022), 2-chlorophenol (024), 2,4-dinitrotoluene (035), 1,2-diphenylhydrazine (037), fluoranthene (039), isophorone (054), bis(2-ethylhexyl) phthalate (066), di-n-butyl phthalate (067), di-n-ethyl phthalate (068), benzo(a)pyrene (073), 3,4-benzofluoranthene (074), benzo(k)fluoroanthene (075), chrysene (076), acenaphthylene (077), benzo(ghi)perylene (079), dibenzo-(a,h)anthracene (082), indeno(1,2,3-c,d)pyrene (083), vinyl chloride (088), and endrin aldehyde (099). This list includes all the polynuclear aromatic hydrocarbon (PAH) compounds and several toxic organics found in drawing spent emulsions not found in rolling spent emulsions. These compounds are included because the Agency believes that any of the PAH's and these other compounds can be substituted for one another to serve as pressure building compounds in the formulations of the emulsified lubricants.

The total toxic organic benefit estimate values (kg/yr) presented in Tables X-3 through X-19 are calculated by multiplying the oil and grease mass (kg/yr) by 0.0015. From the data presented in Section V, it has been determined that the sum of the concentrations of the toxic organics in any given sample is on the average equal to 0.15 percent of the oil and grease concentration in that sample.

Since effective oil and grease removal can remove 97 percent of the TTO, no TTO limitation will be set at BAT because the Agency believes that the oil and grease removals under the BPT limitations should provide adequate removal of toxic organics.

As discussed in Section VII (p. 701), maintaining the correct pH in the treatment system is important to assure adequate removal of toxic metals. The Agency believes that by maintaining the correct pH range for removal of chromium, zinc, and aluminum, adequate removal of the other toxic metals, cadmium, copper, lead, nickel, and selenium, should be assured. The Agency believes that the mechanism and the chemistry of toxic metals removal in a lime and settle system are the same for all of the toxic metals. This theoretical analysis is supported empirically by performance data of lime and settle systems collected by the Agency. The theoretical background for toxic metals removal as well as the performance data have been presented in Section VII. Since chromium, zinc, and aluminum are present at the highest concentrations in raw wastewater streams, these pollutants have been selected to be used to ensure adequate removal of the other toxic metals listed above. Chromium and zinc are considered to be indicator pollutants for cadmium, copper, lead, nickel, and selenium, which were found at treatable levels.

Effluent pH should be maintained within the range of 7.0 to 10.0 at all times. This pH range applies to the clarifier effluent. Maintaining the pH in this range should ensure effective removal of the vast majority of the toxic metals.

ROLLING WITH NEAT OILS SUBCATEGORY

Discharge Flows

Table X-27 lists the BAT wastewater discharge flows for core and ancillary streams that received an allowance under BPT. The flow allowances for BAT for core operations are identical to those of BPT.

Ancillary streams with a BAT discharge allowance are from continuous sheet casting lubricant, solution heat treatment contact cooling, and cleaning or etching baths, rinses, and scrubbers. The bath allowance at BAT is identical to the bath allowance at BPT.

The BAT wastewater discharge flow for the solution heat treatment contact cooling water (heat treatment quench) stream is 2,037 l/kkg (488.5 gal/ton). Of the 89 heat treatment quench operations surveyed, 18 reported recycle of this stream. Eight of these appear to achieve zero discharge of this wastewater stream by practicing total recycle. It is likely, however, that the plants reporting no discharge failed to mention periodic discharge, such as occasional blowdown or discharge with annual cleaning of the cooling tower. Because no technology for avoiding the buildup of solids in completely recycled cooling water is known to be applied in this industry, only nonzero discharge values were used as a basis for the BAT discharge flow. The BAT discharge flow for the solution heat treatment contact cooling water stream is the mean of four plants using recycle for which sufficient data are available on both normalized discharge flow and water use flow (i.e., the percent recycle). The normalized discharge flows for these plants ranged from 881 to 3,059 l/kkg (211 to 733 gal/ton), with a mean of 2,037 l/kkg (488.5 gal/ton), which is selected as the BAT discharge flow.

The BAT wastewater discharge flows for cleaning or etching operations are 179 l/kkg (43 gal/ton) for cleaning or etching baths, 1,391 l/kkg (333.6 gal/ton) for cleaning or etching rinses, and 1,933 l/kkg (463.5 gal/ton) of aluminum cleaned or etched for cleaning or etching scrubber liquor.

The BAT discharge for cleaning or etching baths is identical to that of BPT. At proposal, consideration was given to not establishing a BAT discharge allowance based upon hauling or regeneration of bath solutions. Based on comments received from industry and data obtained since proposal, the Agency has established a bath allowance at BAT.

The BAT wastewater discharge flow for the cleaning or etching rinse is based upon flow reduction using two-stage countercurrent cascade rinsing or other suitable rinsing techniques including but not limited to spray rinsing and simply rinsewater recirculation. The allowance is per bath and associated rinse operation. Plants which have more than one cleaning or etching bath are given an allowance for the rinse that follows each bath. Eighteen of the 44 rinse dischargers reported throughout all of the subcategories meet the BAT flow without further flow reduction. Eleven are known to use recirculating or spray rinsing techniques or a combination of the two. Hot water rinses or treatment of recirculating rinse water are used by four of these 11 plants. Stagnant rinsing is used by three plants which meet the BAT discharge flow, as well as two which do not.

Most of the plants with discharge flows higher than the BAT allowance are forging plants. Five utilize once-through overflow rinsing, two use stagnant rinsing, and two reuse rinse water from one rinse operation for another. Two-stage countercurrent cascade rinsing is used by one plant which could meet the BAT discharge flow by adding a third countercurrent cascade rinsing stage combined with a slight reduction in the rinse ratio. By using two-stage countercurrent cascade rinsing, with an expected 90 percent reduction in rinse water use, 20 of 26 plants can meet the BAT discharge flow. The other six plants would need to add additional countercurrent cascade rinsing stages, reduce their rinse ratio, or use other more efficient rinsing techniques to conserve water. As shown in an example presented in Section VII (p. 776), the reduction in the flow that is achievable with two-stage countercurrent cascade rinsing can be as high as 99.5 percent. For the aluminum forming category the BAT flow allowance is based on 90 percent recycle.

Three of the seven plants with wet air pollution control devices on cleaning or etching operations use water recycle. The BAT wastewater discharge flow for the cleaning or etching scrubber liquor stream is 1,933 l/kkg (463.5 gal/ton), which is based on the mean normalized discharge flow of the two plants using recycle.

The BAT discharge for continuous sheet casting spent lubricants is identical to that of BPT 1.964 l/kkg (0.471 gal/ton). This is based upon recycle of this stream.

Pollutants

The pollutants considered for regulation under BAT are listed in Section VI, along with an explanation of why they have been selected. The pollutants selected for regulation under BAT are chromium (total), cyanide (total), zinc, and aluminum. The organic pollutants, cadmium, copper, lead, nickel, and selenium, listed in Section VI are not regulated under BAT. As discussed previously, oil removal and the limitation placed on oil and grease at BAT should result in reduction in the amount of organic pollutants which are discharged, and by achieving the zinc, chromium, and aluminum limitations, the other metals listed above should also be removed.

Treatment Train

EPA has selected Option 2 as the basis for BAT in this subcategory. Again, this option uses the same end-of-pipe technology as BPT, with the addition of measures to reduce the flows from selected waste streams. The end-of-pipe treatment configuration is shown in Figure X-2. The combination of in-process control and technology significantly increases the removals of pollutants over that achieved by BPT and is cost effective.

Effluent Limitations

Table VII-20 (p. 807) presents the treatment effectiveness corresponding to the BAT model treatment train for pollutant parameters considered in the Rolling with Neat Oils Subcategory. Effluent concentrations (one day maximum and ten day average values) are multiplied by the normalized discharge flows summarized in Table X-27 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table X-28.

Benefits

In establishing BAT, EPA considered the cost of treatment and control and the pollutant reduction benefits to evaluate economic achievability. As shown in Table X-3 the application of BAT to the total Rolling with Neat Oils Subcategory will remove approximately 1,790,870.2 kg/yr (3.940 million lb/yr) of pollutants. As shown in Table X-1 the corresponding capital and annual costs (1982 dollars) for this removal are $16.2 million and $8.13 million per year, respectively. As shown in Table X-9 the application of BAT to direct dischargers only, will remove approximately 1,511,558.8 kg/yr (3.325 million lb/yr) of pollutants. As shown in Table X-2 the corresponding capital and annual costs (1982 dollars) for this removal are $12.5 million and $6.13 million per year, respectively.

ROLLING WITH EMULSIONS SUBCATEGORY

Discharge Flows

Table X-29 lists the BAT wastewater discharge flows for core and ancillary streams that received an allowance under BPT. The flow allowances for the core operations are identical to BPT.

Ancillary streams with a BAT discharge allowance are from solution heat treatment contact cooling, cleaning or etching baths, rinses, and scrubbers, and direct chill casting contact cooling. The BAT wastewater discharge flow for the solution treatment contact cooling water stream is 2,037 l/kkg (488.5 gal/ton). The BAT wastewater discharge flows for cleaning or etching operations are 179 l/kkg (43 gal/ton) for the cleaning or etching bath, 1,686 l/kkg (404.4 gal/ton) for the cleaning or etching rinse, and 1,933 l/kkg (463.5 gal/ton) for cleaning or etching scrubber liquor. Refer to the Rolling with Neat Oils Subcategory portion of this section for further discussion of these flow allowances.

The BAT wastewater discharge flow for direct chill casting operations is 1,329 l/kkg (318.96 gal/ton). This is the same as the BPT discharge flow and is based upon the average of plants that recycle this stream.

Pollutants

The pollutants considered for regulation under BAT are listed in Section VI, along with an explanation of why they have been selected. The pollutants selected for regulation under BAT are chromium (total), cyanide (total), zinc, and aluminum. The organic pollutants, cadmium, copper, lead, nickel, and selenium, listed in Section VI are not regulated under BAT. As discussed previously, oil removal and the limitation placed on oil and grease at BPT should result in reduction in the amount of organic pollutants which are discharged, and by achieving the zinc, chromium, and aluminum limitations, the other metals listed above should also be removed.

Treatment Train

EPA has selected Option 2 as the basis for BAT in this subcategory. Again, this option uses the same end-of-pipe technology as BPT, with the addition of measures to reduce the flows from selected waste streams. The end-of-pipe treatment configuration is shown in Figure X-2. The combination of in-process control and technology significantly increases the removals of pollutants over that achieved by BPT and is cost effective.

Effluent Limitations

Table VII-20 (p. 807) presents the treatment effectiveness corresponding to the BAT model treatment train for pollutant parameters considered in the Rolling with Emulsions Subcategory. Effluent concentrations (one day maximum and ten day average values) are multiplied by the normalized discharge flows summarized in Table X-29 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table X-30.

Benefits

In establishing BAT, EPA considered the cost of treatment and control and the pollutant reduction benefits to evaluate economic achievability. As shown in Table X-4 the application of BAT to the total Rolling with Emulsions Subcategory will remove approximately 12,338,901.1 kg/yr of pollutants (27.15 million lb/yr). As shown in Table X-1 the corresponding capital and annual costs (1982 dollars) for this removal are $16.5 million and $8.71 million per year, respectively. As shown in Table X-10 the application of BAT to direct dischargers only, will remove approximately 10,762,880.8 kg/yr (23.68 million lb/yr) of pollutants. As shown in Table X-2 the corresponding capital and annual costs (1982 dollars) for this removal are $15.1 million and $7.97 million per year, respectively.

EXTRUSION SUBCATEGORY

Discharge Flows

Table X-31 lists the BAT wastewater discharge flows for core and ancillary streams that received an allowance under BPT. The core allocation for BAT is less than BPT due to flow reduction applied to the die cleaning waste streams. The Extrusion BAT core flow allowance is 340.1 l/kkg (81.6 gal/ton).

The BAT wastewater discharge flow for the die cleaning bath and rinse stream is 12.9 l/kkg (3.1 gal/ton). This normalized discharge flow is based upon zero allowance for the die cleaning rinse using flow reduction by countercurrent cascade rinsing and total reuse of the reduced rinse flow as make-up to the die cleaning bath. The allowance for the die cleaning bath contribution is the same as the die cleaning bath BPT allowance. Three plants currently practice total reuse of die cleaning rinse water from bath make-up. Because the average amount of die cleaning rinse discharge, 26.52 l/kkg (6.354 gal/ton), is greater than the average die cleaning bath water use, 17.56 l/kkg (4.212 gal/ton), rinse water flow reduction may be required at BAT. Countercurrent cascade rinsing is the model treatment technology for achieving the flow reduction.

The BAT wastewater discharge flow for the die cleaning scrubber liquor stream is 275.5 l/kkg (66.08 gal/ton), which is the same as the BPT flow. The BAT discharge flow for the miscellaneous nondescript wastewater sources stream is 45.0 l/kkg (10.8 gal/ton).

Ancillary streams with a BAT discharge allowance are from solution and press heat treatment, direct chill casting contact cooling, extrusion press hydraulic fluid leakage, and cleaning or etching baths, rinses and scrubbers.

The BAT wastewater discharge flow for the solution and press heat treatment contact cooling water stream is 2,037 l/kkg (488.5 gal/ton), as discussed in the Rolling with Neat Oils Subcategory of this section.

The BAT wastewater discharge flows for cleaning or etching operations are 179 l/kkg (43 gal/ton) for cleaning or etching baths, 1,391 l/kkg (334 gal/ton) for cleaning or etching rinses, and 1,933 l/kkg (463.5 gal/ton) for cleaning or etching scrubber liquor. Refer to the discussion for the Rolling with Neat Oils Subcategory of this section.

The BAT wastewater discharge flow for direct chill casting contact cooling is 1,329 l/kkg (318.96 gal/ton). This is the same as the BPT discharge flow and is based upon the average of plants that recycle this stream.

The BAT wastewater discharge flow for extrusion press hydraulic fluid leakage is the same as the BPT discharge flow and is based on the average of plants that do not recycle this stream. EPA visited several plants with emulsion-based hydraulic extrusion presses after the public comment period to study the potential for recycle of the hydraulic medium because we were aware that there were plants that were currently doing so. We determined that the modifications required for an existing plant would include rerouting of collection pits and channels which are generally a part of the floorspace and foundation, installation of pumps to transfer the collected hydraulic fluid to a central point for recycle, and possibly installation of a corrugated plate separator to separate insoluble oils and a filter to remove dirt and debris. Recycle was considered for BAT and PSES; however, it was ultimately rejected because of the expense and the complexity of these process changes that would be required for existing plants to install recycle systems.

The degassing scrubber liquor stream is zero allowance at BAT. Application of the alternative fluxing and in-line refining methods discussed in Section VII (p.), eliminate the need for wet air pollution controls associated with degassing of aluminum melts prior to casting. Because this technology is currently available and in use at most aluminum forming plants with casting operations, dry air pollution control has been identified as the BAT control. Aluminum refining is regulated under the nonferrous metals manufacturing category and any pre-refining step before casting that requires air pollution control which generates a wastewater stream should be regulated under the appropriate subcategory of nonferrous metals manufacturing.

Pollutants

The pollutants considered for regulation under BAT are listed in Section VI, along with an explanation of why they have been selected. The pollutants selected for regulation under BAT are chromium (total), cyanide (total), zinc, and aluminum. The organic pollutants, cadmium, copper, lead, nickel, and selenium, listed in Section VI are not regulated under BAT. As discussed previously, oil removal and the limitation placed on oil and grease at BPT should result in reduction in the amount of organic pollutants which are discharged, and by achieving the zinc, chromium, and aluminum limitations, the other metals listed above should also be removed.

Treatment Train

EPA has selected Option 2 as the basis for BAT in this subcategory. Again, this option uses the same end-of-pipe technology as BPT, with the addition of measures to reduce the flows from selected waste streams. The end-of-pipe treatment configuration is shown in Figure X-2. The combination of in-process control and technology significantly increases the removals of pollutants over that achieved by BPT and is cost effective.

Effluent Limitations

Table VII-20 (p. 807) presents the treatment effectiveness corresponding to the BAT model treatment train for pollutant parameters considered in the Extrusion Subcategory. Effluent concentrations (one day maximum and ten day average values) are multiplied by the normalized discharge flows summarized in Table X-31 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table X-32.

Benefits

In establishing BAT, EPA considered the cost of treatment and control and the pollutant reduction benefits to evaluate economic achievability. As shown in Table X-5 the application of BAT to the total Extrusion Subcategory will remove approximately 4,465,352.6 kg/yr (9.824 million lb/yr) of pollutants. As shown in Table X-1 the corresponding capital and annual costs (1982 dollars) for this removal are $34.5 million and $23.7 million per year, respectively. As shown in Table X-11 the application of BAT to direct dischargers only, will remove approximately 3,002,188.1 kg/yr (6.605 million lb/yr) of pollutants. As shown in Table X-2 the corresponding capital and annual costs (1982 dollars) for this removal are $18.3 million and $10.1 million per year, respectively.

FORGING SUBCATEGORY

There are no direct discharging facilities which use forging processes to form aluminum. Consequently, the Agency is excluding the Forging Subcategory from regulation under BPT and BAT. The discussion which follows is presented for consistency and completeness.

Discharge Flows

Table X-33 lists the BAT wastewater discharge flows for core and ancillary streams that received an allowance under BPT. The production normalized discharge flow for the core under BAT is equal to the core discharge flow under BPT.

Ancillary streams with a BAT discharge allowance are from forging scrubbers, solution heat treatment contact cooling, and cleaning or etching baths, rinses, and scrubbers. The BAT wastewater discharge flow for the forging scrubber liquor stream is 94.31 l/kkg (22.65 gal/ton). Three aluminum forming plants with dry air pollution control systems use baghouses or afterburners. Because of high operating and maintenance costs and fire hazards associated with the baghouses, dry air pollution control systems have not been selected for BAT. Of the three plants using wet scrubbers, two recirculate the scrubber water with periodic discharge, while one plant does not recirculate and discharges continuously. The BAT discharge flow is the average of the flows for the two plants with recirculating scrubbers.

The BAT wastewater discharge flow for the solution heat treatment contact cooling water stream is 2,037 l/kkg (488.5 gal/ton), as discussed in the Rolling with Neat Oils Subcategory of this section.

The BAT wastewater discharge flows for cleaning or etching operations are 179 l/kkg (43 gal/ton) for the cleaning or etching bath, 1,391 l/kkg (334 gal/ton) for the cleaning or etching rinse, and 1,933 l/kkg (463.5 gal/ton) for cleaning or etching scrubber liquor. Refer to the discussion for the Rolling with Neat Oils Subcategory of this section.

Pollutants

The pollutants considered for regulation under BAT are listed in Section VI, along with an explanation of why they have been selected. The pollutants selected for regulation under BAT are chromium (total), cyanide (total), zinc, and aluminum. The organic pollutants, cadmium, copper, lead, nickel, and selenium, listed in Section VI are not regulated under BAT. As previously discussed, oil removal and the limitation placed on oil and grease should result in reduction in the amount of organic pollutants which are discharged, and by achieving the zinc, chromium, and aluminum limitations, the other metals listed above should also be removed.

Treatment Train

EPA has selected Option 2 as the basis for BAT in this subcategory. Again, this option uses the same technology as BPT, with the addition of measures to reduce the flows from selected waste streams. The end-of-pipe treatment configuration is shown in Figure X-2. The combination of in-process control and technology significantly increases the removals of pollutants over that achieved by BPT and is cost effective.

Effluent Limitations

Table VII-20 (p. 807) presents the treatment effectiveness corresponding to the BAT treatment train for pollutant parameters considered in the Forging Subcategory. Effluent concentrations (one day maximum and ten day average values) are multiplied by the normalized discharge flows summarized in Table X-33 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table X-34.

Benefits

In establishing BAT, EPA considered the cost of treatment and control and the pollutant reduction benefits to evaluate economic achievability. As shown in Table X-6 the application of BAT level technology to the total Forging Subcategory will remove approximately 794,745.9 kg/yr (1.748 million lb/yr) of pollutants. As shown in Table X-1 the corresponding capital and annual costs (1982 dollars) for this removal are $4.87 million and $2.32 million per year, respectively.

DRAWING WITH NEAT OILS SUBCATEGORY

Discharge Flows

Table X-35 lists the BAT wastewater discharge flows for core and ancillary streams that received an allowance under BPT. The BAT discharge flow from the core is the same as the BPT discharge flow.

Ancillary streams with a BAT discharge allowance are from continuous rod casting, solution heat treatment contact cooling, and cleaning or etching baths, rinses, and scrubbers.

The continuous rod casting contact cooling stream is reduced under BAT to 193.3 l/kkg (46.4 gal/ton) of aluminum cast, with the application of recycle. The flow allowance is based on the average of three flows, two of which are from primary aluminum plants practicing recycle. The third is based on the application of 90 percent recycle of the one aluminum forming flow available. One aluminum forming plant reported recycle with only periodic discharge of the continuous rod casting cooling stream, however, they did not provide data to calculate their production normalized flows. Seventeen aluminum forming plants, five primary aluminum plants and one secondary aluminum plant, which recycle a similar type of cooling stream to direct chill casting, reported recycle rates of greater than 90 percent. Therefore, the Agency believes that the flow based on the application of recycle is appropriate for this waste stream.

The BAT wastewater discharge flow for the solution heat treatment contact cooling water stream is 2,037 l/kkg (488.5 gal/ton), as discussed in the Rolling with Neat Oils Subcategory of this section.

The BAT wastewater discharge flows for cleaning or etching operations are 179 l/kkg (43 gal/ton) for the cleaning or etching bath, 1,391 l/kkg (334 gal/ton) for the cleaning or etching rinse, and 1,933 l/kkg (463.5 gal/ton) for the cleaning or etching scrubber liquor. Refer to the discussion for the Rolling with Neat Oils Subcategory of this section.

Pollutants

The pollutants considered for regulation under BAT are listed in Section VI, along with an explanation of why they have been selected. The pollutants selected for regulation under BAT are chromium (total), cyanide (total), zinc, and aluminum. The organic pollutants, cadmium, copper, lead, nickel, and selenium, listed in Section VI are not regulated under BAT. As discussed previously, oil removal and the limitation placed on oil and grease at BPT should result in reduction in the amount of organic pollutants which are discharged, and by achieving the zinc, chromium, and aluminum limitations, the other metals listed above should also be removed.

Treatment Train

EPA has selected Option 2 as the basis for BAT in this subcategory. Again, this option uses the same end-of-pipe technology as BPT, with the addition of measures to reduce the flows from selected waste streams. The end-of-pipe treatment configuration is shown in Figure X-2. The combination of in-process control and technology significantly increases the removals of pollutants over that achieved by BPT and is cost effective.

Effluent Limitations

Table VII-20 (p. 807) presents the treatment effectiveness corresponding to the BAT model treatment train for pollutant parameters considered in the Drawing with Neat Oils Subcategory. Effluent concentrations (one day maximum and ten day average values) are multiplied by the normalized discharge flows summarized in Table X-35 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table X-36.

Benefits

In establishing BAT, EPA considered the cost of treatment and control and the pollutant reduction benefits to evaluate economic achievability. As shown in Table X-7 the application of BAT to the total Drawing with Neat Oils Subcategory will remove approximately 788,995.7 kg/yr (1.736 million lb/yr) of pollutants. As shown in Table X-1 the corresponding capital and annual costs (1982 dollars) for this removal are $3.96 million and $1.96 million per year, respectively. As shown in Table X-12 the application of BAT to direct dischargers only, will remove approximately 559,481.0 kg/yr (1.231 million lb/yr) of pollutants. As shown in Table X-2 the corresponding capital and annual costs (1982 dollars) for this removal are $2.21 million and $1.00 million per year, respectively.

DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Discharge Flows

Table X-37 lists the BAT wastewater discharge flows for core and ancillary streams that received an allowance under BPT. The BAT discharge flow for the core of this subcategory is equal to the BPT discharge flow.

Ancillary streams with a BAT discharge allowance are from continuous rod casting, solution heat treatment contact cooling, and cleaning or etching baths, rinses, and scrubbers.

The BAT wastewater discharge flow for the continuous rod casting lubricant and contact cooling water are discussed in the Drawing with Neat Oils Subcategory of this section. The lubricant discharge allowance is 1.964 l/kkg (0.471gpt) and the contact cooling water allowance is 193.9 l/kkg (46.54 gpt).

The BAT wastewater discharge flow for the solution heat treatment contact cooling water stream is 2,037 l/kkg (488.5 gal/ton), as discussed in the Rolling with Neat Oils Subcategory of this section.

The BAT wastewater discharge flows for cleaning or etching operations are 179 l/kkg (43 gal/ton) for the cleaning or etching bath, 1,391 l/kkg (334 gal/ton) for the cleaning or etching rinse, and 1,933 l/kkg (463.5 gal/ton) for cleaning or etching scrubber liquor. Refer to the discussion for the Rolling with Neat Oils Subcategory of this section.

Pollutants

The pollutants considered for regulation under BAT are listed in Section VI, along with an explanation of why they have been selected. The pollutants selected for regulation under BAT are chromium (total), cyanide (total), zinc, and aluminum. The organic pollutants, cadmium, copper, lead, nickel, and selenium, listed in Section VI are not regulated under BAT. As discussed previously, oil removal and the limitation placed on oil and grease at BPT should result in reduction in the amount of organic pollutants which are discharged, and by achieving the zinc, chromium, and aluminum limitations, the other metals listed above should also be removed.

Treatment Train

EPA has selected Option 2 as the basis for BAT in this subcategory. Again, this option uses the same end-of-pipe technology as BPT, with the addition of measures to reduce the flows from selected waste streams. The end-of-pipe treatment configuration is shown in Figure X-2. The combination of in-process control and technology significantly increases the removals of pollutants over that achieved by BPT and is cost effective.

Effluent Limitations

Table VII-20 (p. 807) presents the treatment effectiveness corresponding to the BAT model treatment train for pollutant parameters considered in the Drawing with Emulsions or Soaps Subcategory. Effluent concentrations (one day maximum and ten day average values) are multiplied by the normalized discharge flows summarized in Table X-37 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table X-38.

Benefits

In establishing BAT, EPA considered the cost of treatment and control and the pollutant reduction benefits to evaluate economic achievability. As shown in Table X-8 the application of BAT to the total Drawing with Emulsions or Soaps Subcategory will remove approximately 140,583.4 kg/yr (0.309 million lb/yr) of pollutants. As shown in Table X-1 the corresponding capital and annual costs (1982 dollars) for this removal are $0.62 million and $0.27 million per year, respectively. As shown in Table X-13 the application of BAT to direct dischargers only, will remove approximately 57,501.6 kg/yr (0.127 million lb/yr) of pollutants. As shown in Table X-2 the corresponding capital and annual costs (1982 dollars) for this removal are $0.41 million and $0.18 million per year, respectively.

Table X-1

CAPITAL AND ANNUAL COST ESTIMATES FOR BAT OPTIONS
TOTAL SUBCATEGORY

Subcategory	Option 1	Option 2	Option 3	Option 4*	Option 5*	Option 6*
Rolling With Neat Oils						
Capital	13,495,033	16,195,100	19,476,500	29,302,200	31,263,600	----
Annual	10,717,584	8,131,200	9,217,700	9,897,400	10,267,800	----
Rolling With Emulsions						
Capital	14,657,910	16,540,000	20,086,200	53,634,500	55,796,300	----
Annual	15,231,015	8,710,800	9,722,000	15,646,400	16,121,800	----
Extrusion						
Capital	34,602,686	34,473,844	38,145,110	24,066,200	26,605,700	----
Annual	25,496,209	23,650,399	24,871,552	11,160,700	12,060,300	----
Forging						
Capital	11,452,866	4,871,590	5,342,132	3,563,000	3,905,400	3,937,200
Annual	8,283,595	2,315,186	2,442,205	1,717,500	1,809,300	1,858,900
Drawing With Neat Oils						
Capital	4,688,064	3,960,234	4,301,004	2,895,900	3,381,000	----
Annual	2,938,396	1,959,170	2,060,678	1,315,500	1,495,000	----
Drawing With Emulsions or Soaps						
Capital	1,053,630	618,900	668,000	837,000	873,700	----
Annual	818,117	274,009	286,501	354,500	363,900	----
Totals						
Capital	79,950,189	76,659,668	88,018,946			
Annual	63,484,916	45,040,764	48,600,636			

*Costs for Options 4, 5, and 6 are given in 1978 dollars. These costs were not revised for promulgation.
Costs for Options 1, 2, and 3 are given in 1982 dollars.

Table X-2

CAPITAL AND ANNUAL COST ESTIMATES FOR BAT OPTIONS
DIRECT DISCHARGERS

Subcategory	BPT Option 1	BAT Option 2	Option 3	Option 4*	Option 5*
Rolling With Neat Oils					
Capital	9,553,000	12,479,200	15,160,700	26,119,400	27,601,600
Annual	8,200,300	6,127,500	7,012,400	8,292,400	8,556,800
Rolling With Emulsions					
Capital	13,957,400	15,118,300	18,456,700	52,408,400	54,390,800
Annual	14,476,600	7,972,300	8,915,300	14,996,900	15,484,200
Extrusion					
Capital	21,145,001	18,306,031	20,387,892	12,688,900	14,226,700
Annual	13,025,772	10,106,251	10,701,690	5,297,700	5,988,500
Drawing With Neat Oils					
Capital	3,026,700	2,208,200	2,392,100	1,874,400	2,274,800
Annual	1,747,300	997,900	1,046,200	821,800	977,100
Drawing With Emulsions or Soaps					
Capital	733,200	409,000	442,600	469,700	494,800
Annual	474,800	179,300	187,700	165,700	172,000
Totals					
Capital	48,415,301	48,520,731	56,839,992		
Annual	37,924,772	25,383,251	27,863,290		

*Costs for Options 4 and 5 were not revised for promulgation. Options 4 and 5 costs are in 1978 dollars. Costs for Options 1, 2, and 3 are in 1982 dollars.

Table X-3

POLLUTANT REDUCTION BENEFITS*
ROLLING WITH NEAT OILS SUBCATEGORY

	Pollutant	Raw Waste	Option 1		Option 2	
	Flow (l/yr)	5.176 x 10^9	5.176 x 10^9		961.3 x 10^6	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	15.5	0.0	15.5	0.0	15.5
119.	Chromium	7,061.9	6,775.4	286.5	6,991.0	70.7
120.	Copper	3,003.0	951.0	2,052.0	2,482.8	520.2
121.	Cyanide	37.1	0.0	37.1	0.0	37.1
122.	Lead	1,989.3	1,546.1	443.2	1,869.6	119.7
124.	Nickel	524.6	0.0	524.6	38.7	485.9
128.	Zinc	5,907.2	4,832.9	1,074.3	5,641.7	265.5
	Aluminum	339,867.6	332,440.0	7,427.5	335,432.3	4,435.1
	Oil and Grease	1,087,360.4	1,042,742.8	44,617.6	1,069,700.9	17,659.5
	TSS	385,870.0	334,759.0	51,111.0	367,108.6	18,671.3
	Total Toxic Organics	1,631.0	1,564.1	66.9	1,604.6	26.5
	Total Toxic Metals	18,501.5	14,105.4	4,396.1	17,023.8	1,477.5
	Total Toxics	20,169.6	15,669.5	4,500.1	18,628.4	1,541.1
	Total Conventionals	1,473,230.4	1,377,501.8	95,728.6	1,436,809.5	36,420.8
	Total Pollutants	1,833,267.6	1,725,611.3	107,656.2	1,790,870.2	42,397.0
	Sludge	-----	16,383,700		16,791,910	

*The data tabulated represent performance of technology applied to all aluminum forming plants in the subcategory.

Table X-3 (Continued)

POLLUTANT REDUCTION BENEFITS*
ROLLING WITH NEAT OILS SUBCATEGORY

	Pollutant	Option 3		Option 4		Option 5	
	Flow (l/yr)	961.3 x 10^6		904.3 x 10^6		904.3 x 10^6	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	15.5	0.2	15.4	0.2	15.3
119.	Chromium	6,999.9	62.0	6,995.6	66.3	7,004.0	58.0
120.	Copper	2,651.0	351.9	2,515.9	487.0	2,673.2	329.7
121.	Cyanide	0.0	37.1	0.1	37.1	0.1	37.0
122.	Lead	1,905.0	84.3	1,876.4	112.9	1,909.5	79.8
124.	Nickel	333.4	191.3	63.9	460.7	343.8	180.8
128.	Zinc	5,703.6	203.5	5,658.7	248.5	5,716.7	190.5
	Aluminum	335,759.9	4,107.6	335,495.6	4,371.9	335,802.0	4,065.5
	Oil and Grease	1,069,700.9	17,659.5	1,070,270.6	17,089.8	1,070,270.6	17,089.8
	TSS	375,428.3	10,441.7	367,792.2	18,077.8	375,576.4	10,293.6
	Total Toxic Organics	1,604.6	26.5	1,605.4	25.6	1,605.4	25.6
	Total Toxic Metals	17,592.9	908.5	17,110.7	1,390.8	17,647.4	854.1
	Total Toxics	19,197.5	972.1	18,716.2	1,453.5	19,252.9	916.7
	Total Conventionals	1,445,129.2	28,101.2	1,438,062.8	35,167.6	1,445,847.0	27,383.4
	Total Pollutants	1,800,086.6	33,180.9	1,792,274.6	40,993.0	1,800,901.9	32,365.6
	Sludge	16,855,940		16,801,430		16,861,490	

*The data tabulated represent performance of technology applied to all aluminum forming plants in the subcategory.

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table X-4

POLLUTANT REDUCTION BENEFITS*
ROLLING WITH EMULSIONS SUBCATEGORY

	Pollutant	Raw Waste	Option 1		Option 2	
	Flow (l/yr)	32.21×10^9	9.935×10^9		8.030×10^9	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	61.0	1.4	59.6	1.4	59.6
119.	Chromium	4,856.7	4,086.5	770.2	4,217.1	639.6
120.	Copper	4,350.9	182.5	4,168.5	205.8	4,145.2
121.	Cyanide	250.1	1.9	248.2	1.9	248.2
122.	Lead	15,147.7	13,986.4	1,161.3	14,182.2	965.5
124.	Nickel	671.7	16.8	654.9	16.8	654.9
128.	Zinc	9,493.0	6,605.2	2,887.9	7,094.6	2,398.5
	Aluminum	279,025.6	266,764.3	12,261.2	268,575.0	10,450.6
	Oil and Grease	7,877,285.4	7,777,001.3	100,284.0	7,793,313.3	83,972.0
	TSS	4,339,260.1	4,220,028.5	119,231.6	4,239,603.0	99,657.2
	Total Toxic Organics	11,815.9	11,665.5	150.4	11,690.0	126.0
	Total Toxic Metals	34,581.0	24,878.8	9,702.4	25,717.9	8,863.3
	Total Toxics	46,647.0	36,546.2	10,101.0	37,409.8	9,237.5
	Total Conventionals	12,216,545.5	11,997,029.8	219,515.6	12,032,916.3	183,629.2
	Total Pollutants	12,216,545.5	12,300,340.3	241,877.8	12,338,901.1	203,317.3
	Sludge	-----	67,766,350		68,004,860	

*The data tabulated represent performance of technology applied to all aluminum forming plants in the subcategory.

Table X-4 (Continued)

POLLUTANT REDUCTION BENEFITS*
ROLLING WITH EMULSIONS SUBCATEGORY

	Pollutant	Option 3		Option 4		Option 5	
	Flow (l/yr)	8.030 x 10^9		7.673 x 10^9		7.673 x 10^9	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	2.2	58.8	3.5	57.5	3.6	57.4
119.	Chromium	4,297.1	559.6	4,245.7	611.0	4,322.0	534.7
120.	Copper	1,229.7	3,121.2	236.4	4,114.5	1,369.1	2,981.9
121.	Cyanide	2.6	247.5	3.8	246.3	3.8	246.2
122.	Lead	14,501.9	645.8	14,225.0	922.7	14,530.5	617.2
124.	Nickel	26.8	645.0	32.5	639.2	32.8	638.9
128.	Zinc	7,654.2	1,838.8	7,201.7	2,291.4	7,736.3	1,756.7
	Aluminum	271,533.1	7,492.4	268,971.5	10,054.1	271,797.6	7,228.0
	Oil and Grease	7,793,313.3	83,972.0	7,796,885.6	80,399.9	7,796,885.6	80,399.9
	TSS	4,314,757.3	24,503.0	4,243,889.7	95,370.4	4,315,686.0	23,574.1
	Total Toxic Organics	11,690.0	126.0	11,695.3	120.6	11,695.3	120.6
	Total Toxic Metals	27,711.9	6,869.2	25,944.8	8,636.3	27,994.3	6,586.8
	Total Toxics	39,404.5	7,242.7	37,643.9	9,003.2	39,693.4	6,953.6
	Total Conventionals	12,108,070.6	108,475.0	12,040,775.3	175,770.3	12,112,571.6	103,974.0
	Total Pollutants	12,419,008.2	123,210.1	12,347,390.7	194,827.6	12,424,062.6	118,155.6
	Sludge	68,482,400		68,057,960		68,515,120	

*The data tabulated represent performance of technology applied to all aluminum forming plants in the subcategory.

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table X-5

POLLUTANT REDUCTION BENEFITS*
EXTRUSION SUBCATEGORY

	Pollutant	Raw Waste	Option 1		Option 2	
	Flow (l/yr)	19.51×10^9	15.27×10^9		4.19×10^9	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	71.2	0.0	71.2	0.0	71.2
119.	Chromium	155,481.0	154,570.7	910.3	155,260.3	220.7
120.	Copper	11,214.0	2,925.2	8,288.8	9,002.6	2,211.4
121.	Cyanide	1,729.2	718.5	1,010.7	1,455.2	274.0
122.	Lead	3,962.5	2,232.7	1,729.8	3,489.6	472.9
124.	Nickel	5,717.5	0.0	5,717.5	3,547.0	2,170.5
128.	Zinc	17,502.0	13,229.5	4,272.5	16,377.1	1,124.9
	Aluminum	1,710,770.4	1,692,118.2	18,652.2	1,703,710.6	7,059.8
	Oil and Grease	564,662.9	409,832.7	154,830.2	514,608.4	50,054.5
	TSS	2,111,864.0	1,931,539.2	180,324.8	2,057,028.4	54,835.6
	Total Toxic Organics	847.0	614.7	232.3	771.9	75.1
	Total Toxic Metals	193,948.1	172,654.2	21,293.9	187,778.1	6,170.0
	Total Toxics	196,524.3	173,987.5	22,536.8	190,005.2	6,519.1
	Total Conventionals	2,676,526.9	2,341,371.9	335,155.0	2,571,636.8	104,890.1
	Total Pollutants	4,583,821.7	4,207,477.7	376,344.0	4,465,352.6	118,469.1
	Sludge	-----	92,422,630		94,163,780	

*The data tabulated represent performance of technology applied to all aluminum forming plants in the subcategory.

Table X-5 (Continued)

POLLUTANT REDUCTION BENEFITS*
EXTRUSION SUBCATEGORY

	Pollutant	Option 3		Option 4†		Option 5†	
	Flow (l/yr)	4.19 x 10^9		4.515 x 10^9		4.515 x 10^9	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	71.2	0.0	88.8	1.1	87.8
119.	Chromium	155,298.6	182.4	146,343.8	322.7	146,384.1	282.3
120.	Copper	9,728.4	1,485.6	11,544.8	2,349.9	12,311.0	1,583.6
121.	Cyanide	1,543.0	186.2	1,331.5	275.6	1,414.7	192.5
122.	Lead	3,642.4	320.1	4,006.3	505.4	4,167.7	344.2
124.	Nickel	4,884.1	833.4	4,139.0	2,298.8	5,550.4	887.3
128.	Zinc	16,644.7	857.3	18,253.4	1,209.9	18,535.7	927.6
	Aluminum	1,705,124.1	5,646.3	1,973,153.0	9,968.1	1,974,645.3	8,475.9
	Oil and Grease	514,608.4	50,054.5	580,781.1	54,313.8	580,781.1	54,313.8
	TSS	2,092,903.9	18,960.1	2,044,153.2	61,320.6	2,082,062.5	23,411.4
	Total Toxic Organics	771.9	75.1	871.2	81.5	871.2	81.5
	Total Toxic Metals	190,299.9	3,648.2	184,287.3	6,775.5	186,950.0	4,112.8
	Total Toxics	192,614.8	3,909.5	186,490.0	7,132.6	189,235.9	4,386.8
	Total Conventionals	2,607,546.5	68,980.4	2,624,934.3	115,634.4	2,662,843.6	77,725.2
	Total Pollutants	4,505,285.3	78,536.4	4,784,577.3	132,735.1	4,826,724.8	90,587.9
	Sludge	94,461,690		70,745,010		71,042,400	

*The data tabulated represent performance of technology applied to all aluminum forming plants in the subcategory.

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

†Options 4 and 5 benefits were not revised for promulgation.

Table X-6

POLLUTANT REDUCTION BENEFITS*
FORGING SUBCATEGORY

	Pollutant	Raw Waste	Option 1		Option 2	
	Flow (l/yr)	2.201×10^9	2.201×10^9		285.6×10^6	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	13.1	0.0	13.1	0.0	13.1
119.	Chromium	4,335.8	4,231.3	104.4	4,321.0	14.8
120.	Copper	3,558.4	2,792.4	766.0	3,442.1	116.1
121.	Cyanide	40.5	0.0	40.5	19.5	21.0
122.	Lead	1,575.1	1,400.5	174.6	1,534.9	40.1
124.	Nickel	592.7	0.0	592.7	487.3	105.4
128.	Zinc	7,381.8	6,990.2	391.6	7,326.3	55.5
	Aluminum	442,413.5	436,392.9	6,020.6	437,636.5	4,777.0
	Oil and Grease	46,220.3	21,503.9	24,716.4	32,707.7	13,512.6
	TSS	320,218.8	293,777.1	26,441.7	307,221.5	12,997.2
	Total Toxic Organics	84.4	32.3	52.2	49.1	35.4
	Total Toxic Metals	17,456.9	15,414.4	2,042.4	17,111.6	345.0
	Total Toxics	17,581.8	15,446.7	2,135.1	17,180.2	401.4
	Total Conventionals	366,439.1	315,281.0	51,158.1	339,929.2	26,509.8
	Total Pollutants	826,434.4	767,120.6	59,313.8	794,745.9	31,688.2
	Sludge	-----	14,001,910		14,189,570	

*The data tabulated represent performance of technology applied to all aluminum forming plants in the subcategory.

Table X-6 (Continued)

POLLUTANT REDUCTION BENEFITS*
FORGING SUBCATEGORY

Pollutant	Option 3	
Flow (l/yr)	285.6×10^6	
	Removed (kg/yr)	Discharged (kg/yr)
Cadmium	4.1	9.0
Chromium	4,322.9	12.9
Copper	3,477.3	81.1
Cyanide	23.7	16.8
Lead	1,542.3	32.7
Nickel	552.0	40.7
Zinc	7,339.3	42.5
Aluminum	437,704.9	4,708.5
Oil and Grease	32,707.7	13,512.6
TSS	308,959.6	11,259.2
Total Toxic Organics	49.1	35.4
Total Toxic Metals	17,237.9	218.9
Total Toxics	17,310.7	271.1
Total Conventionals	341,667.3	24,771.8
Total Pollutants	796,682.9	29,751.4
Sludge	14,203,250	

Table X-6 (Continued)

POLLUTANT REDUCTION BENEFITS*
FORGING SUBCATEGORY

	Pollutant	Option 4		Option 5		Option 6	
	Flow (l/yr)	285.3×10^6		285.3×10^6		285.3×10^6	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	13.1	4.1	9.0	4.1	9.0
119.	Chromium	4,321.0	14.8	4,322.9	12.9	4,322.9	12.9
120.	Copper	3,442.3	116.0	3,477.4	81.0	3,477.4	81.0
121.	Cyanide	19.5	21.0	23.8	16.7	23.8	16.7
122.	Lead	1,535.0	40.1	1,542.4	32.7	1,542.4	32.7
124.	Nickel	487.4	105.3	552.0	40.6	552.0	40.6
128.	Zinc	7,326.4	55.4	7,339.4	42.4	7,339.4	42.4
	Aluminum	437,636.8	4,776.7	437,705.1	4,708.3	437,705.1	4,708.3
	Oil and Grease	32,710.2	13,510.1	32,710.2	13,510.1	32,710.2	13,510.1
	TSS	307,224.6	12,994.2	308,960.2	11,258.6	308,960.2	11,258.6
	Total Toxic Organics	49.1	35.4	49.1	35.4	64.2	20.3
	Total Toxic Metals	17,112.1	344.7	17,238.2	218.6	17,238.2	218.6
	Total Toxics	17,180.7	401.1	17,311.1	270.7	17,326.2	255.6
	Total Conventionals	339,934.8	26,504.3	341,670.4	24,768.7	341,670.4	24,768.7
	Total Pollutants	794,752.3	31,682.1	796,686.6	29,747.7	796,701.7	29,732.6
	Sludge	14,189,620		14,203,280		14,203,280	

*The data tabulated represent performance of technology applied to all aluminum forming plants in the subcategory.

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table X-7

POLLUTANT REDUCTION BENEFITS*
DRAWING WITH NEAT OILS SUBCATEGORY

	Pollutant	Raw Waste	Option 1		Option 2	
	Flow (l/yr)	2.446×10^9	2.446×10^9		375.1×10^6	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	13.0	0.0	13.0	0.0	13.0
119.	Chromium	8,041.3	7,913.2	128.1	8,018.8	22.4
120.	Copper	3,383.2	2,445.9	937.3	3,212.2	171.0
121.	Cyanide	79.0	32.5	46.5	53.2	25.8
122.	Lead	1,403.2	1,194.1	209.0	1,352.7	50.5
124.	Nickel	569.7	0.0	569.7	410.0	159.8
128.	Zinc	7,089.6	6,609.2	480.5	7,005.5	84.0
	Aluminum	419,098.0	413,012.3	6,085.7	414,479.1	4,619.0
	Oil and Grease	69,120.7	42,114.2	27,006.4	55,327.4	13,793.3
	TSS	312,573.5	283,198.0	29,375.4	299,053.8	13,519.7
	Total Toxic Organics	103.7	63.2	40.5	83.0	20.7
	Total Toxic Metals	20,500.0	18,162.4	2,337.6	19,999.2	500.7
	Total Toxics	20,682.7	18,258.1	2,424.6	20,135.4	547.2
	Total Conventionals	381,694.2	325,312.2	56,381.8	354,381.2	27,313.0
	Total Pollutants	821,474.9	756,582.6	64,892.1	788,995.7	32,479.2
	Sludge	-----	13,422,830		13,642,080	

*The data tabulated represent performance of technology applied to all aluminum forming plants in the subcategory.

Table X-7 (Continued)

POLLUTANT REDUCTION BENEFITS*
DRAWING WITH NEAT OILS SUBCATEGORY

	Pollutant	Option 3		Option 4		Option 5	
	Flow (l/yr)	375.1×10^6		373.6×10^6		373.6×10^6	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.4	12.6	0.0	13.0	0.5	12.6
119.	Chromium	8,021.7	19.6	8,019.0	22.3	8,021.7	19.6
120.	Copper	3,265.5	117.7	3,213.1	170.2	3,266.0	117.2
121.	Cyanide	58.5	20.5	53.2	25.8	58.5	20.4
122.	Lead	1,363.9	39.2	1,352.8	50.4	1,364.1	39.2
124.	Nickel	508.0	61.7	410.8	158.9	508.4	61.4
128.	Zinc	7,025.1	64.5	7,005.9	83.7	7,025.4	64.1
	Aluminum	414,582.7	4,515.3	414,480.7	4,617.3	414,583.8	4,514.3
	Oil and Grease	55,327.4	13,793.3	55,342.1	13,778.6	55,342.1	13,778.6
	TSS	301,688.3	10,885.2	299,071.5	13,502.1	301,692.2	10,881.4
	Total Toxic Organics	83.0	20.7	83.0	20.7	83.0	20.7
	Total Toxic Metals	20,184.6	315.3	20,001.6	498.5	20,186.1	314.1
	Total Toxics	20,326.1	356.5	20,137.8	545.0	20,327.6	355.2
	Total Conventionals	357,015.7	24,678.5	354,413.6	27,280.7	357,034.3	24,660.0
	Total Pollutants	791,924.5	29,550.3	789,032.1	32,443.0	791,945.7	29,529.5
	Sludge	13,662,720		13,642,330		13,662,870	

*The data tabulated represent performance of technology applied to all aluminum forming plants in the subcategory.

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table X-8

POLLUTANT REDUCTION BENEFITS* DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

	Pollutant	Raw Waste	Option 1		Option 2	
	Flow (l/yr)	413.5 x 10^6	413.5 x 10^6		110.7 x 10^6	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	1.2	0.0	1.2	0.0	1.2
119.	Chromium	683.2	653.8	29.4	675.0	8.3
120.	Copper	200.8	121.7	79.1	163.8	37.0
121.	Cyanide	3.2	0.0	3.2	0.0	3.2
122.	Lead	134.0	88.6	45.3	120.3	13.6
124.	Nickel	36.0	0.0	36.0	18.8	17.3
128.	Zinc	390.2	332.1	58.3	358.5	31.8
	Aluminum	21,837.2	21,216.5	620.8	21,498.5	338.8
	Oil and Grease	94,671.5	90,405.7	4,265.8	93,048.6	1,623.0
	TSS	26,352.1	21,388.9	4,963.1	24,560.3	1,791.7
	Total Toxic Organics	142.0	135.6	6.4	139.6	2.4
	Total Toxic Metals	1,445.4	1,196.2	249.3	1,336.4	109.2
	Total Toxic	1,590.6	1,331.8	258.9	1,476.0	114.8
	Total Conventionals	121,023.6	111,794.6	9,228.9	117,608.9	3,414.7
	Total Pollutants	144,451.4	134,342.9	10,108.6	140,583.4	3,868.3
	Sludge	-----	1,168,030		1,206,920	

*The data tabulated represent performance of technology applied to all aluminum forming plants in the subcategory.

Table X-8 (Continued)

POLLUTANT REDUCTION BENEFITS*
DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

	Pollutant	Option 3		Option 4		Option 5	
	Flow (l/yr)	110.7 x 10^6		90.32 x 10^6		90.32 x 10^6	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	1.2	0.1	1.1	0.1	1.1
119.	Chromium	675.9	7.3	676.4	6.8	677.3	5.9
120.	Copper	168.3	32.5	168.9	31.9	172.1	28.7
121.	Cyanide	0.1	3.1	0.0	3.2	0.2	3.0
122.	Lead	124.6	9.4	122.8	11.1	126.3	7.7
124.	Nickel	25.3	10.7	20.4	15.6	26.2	9.8
128.	Zinc	365.9	24.3	364.6	25.6	370.6	19.7
	Aluminum	21,537.7	299.6	21,521.2	316.2	21,552.8	284.4
	Oil and Grease	93,048.6	1,623.0	93,252.6	1,418.9	93,252.6	1,418.9
	TSS	25,555.3	796.8	24,805.1	1,547.0	25,608.3	743.7
	Total Toxic Organics	139.6	2.4	139.9	2.1	139.9	2.1
	Total Toxic Metals	1,360.0	85.4	1,353.2	92.1	1,372.6	72.9
	Total Toxics	1,499.7	90.9	1,493.1	97.4	1,512.7	78.0
	Total Conventionals	118,603.9	2,419.8	118,057.7	2,965.9	118,860.9	2,162.6
	Total Pollutants	141,641.3	2,810.3	141,072.0	3,379.5	141,926.4	2,525.0
	Sludge	1,213,400		1,210,000		1,215,250	

*The data tabulated represent performance of technology applied to all aluminum forming plants in the subcategory.

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table X-9

POLLUTANT REDUCTION BENEFITS - DIRECT DISCHARGERS
ROLLING WITH NEAT OILS SUBCATEGORY

	Pollutant	Raw Waste	Option 1*		Option 2	
	Flow (l/yr)	4.142×10^9	4.142×10^9		917.9×10^6	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	14.7	0.0	14.7	0.0	14.7
119.	Chromium	6,875.7	6,598.5	277.2	6,808.3	67.3
120.	Copper	2,958.6	942.3	2,016.3	2,463.6	495.0
121.	Cyanide	36.0	0.0	36.0	0.0	36.0
122.	Lead	1,785.0	1,355.7	429.3	1,670.5	114.5
124.	Nickel	518.5	0.0	518.5	38.7	479.8
128.	Zinc	5,862.1	4,822.7	1,039.4	5,609.6	252.5
	Aluminum	338,567.6	333,269.1	7,298.5	334,180.5	4,387.0
	Oil and Grease	838,422.8	794,967.5	43,455.3	821,196.8	17,226.0
	TSS	356,600.2	306,883.9	49,716.3	338,359.0	18,241.1
	Total Toxic Organics					
	Total Toxic Metals	1,257.6	1,192.5	65.2	1,231.8	25.8
	Total Toxics	18,014.6	13,719.2	4,295.4	16,590.7	1,423.8
	Total Conventionals	19,308.2	14,911.7	4,396.6	17,822.5	1,485.6
	Total Pollutants	1,195,023.0	1,101,851.4	93,171.6	1,159,555.8	35,467.1
		1,552,898.8	1,448,032.2	104,866.7	1,511,558.8	41,339.7
	Sludge	-----	15,024,360		15,365,540	

*Option 1 is BAT=BPT

Table X-9 (Continued)

POLLUTANT REDUCTION BENEFITS - DIRECT DISCHARGERS
ROLLING WITH NEAT OILS SUBCATEGORY

	Pollutant	Option 3		Option 4		Option 5	
	Flow (l/yr)	917.9×10^6		875.1×10^6		875.1×10^6	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	14.7	0.0	14.7	0.0	14.7
119.	Chromium	6,816.8	58.9	6,811.8	63.9	6,819.8	55.9
120.	Copper	2,623.6	335.0	2,488.5	470.1	2,640.3	318.3
121.	Cyanide	0.0	36.0	0.0	36.0	0.0	36.0
122.	Lead	1,704.2	80.9	1,675.6	109.4	1,707.6	77.4
124.	Nickel	333.3	185.2	63.2	455.3	342.8	175.7
128.	Zinc	5,668.5	193.6	5,622.4	239.7	5,678.3	183.8
	Aluminum	334,492.0	4,075.6	334,228.1	4,339.5	334,523.7	4,043.9
	Oil and Grease	821,196.8	17,226.0	821,625.4	16,797.4	821,625.4	16,797.4
	TSS	346,271.2	10,329.0	338,873.3	17,726.8	346,382.6	10,217.6
	Total Toxic Organics	1,231.8	25.8	1,232.4	25.2	1,232.4	25.2
	Total Toxic Metals	17,146.4	868.3	16,661.5	1,353.1	17,188.8	825.8
	Total Toxics	18,378.2	930.1	17,893.9	1,414.3	18,421.2	887.0
	Total Conventionals	1,167,468.0	27,555.0	1,160,498.7	34,524.2	1,168,008.0	27,015.0
	Total Pollutants	1,520,338.2	32,560.7	1,512,620.7	40,278.0	1,520,952.9	31,945.9
	Sludge	15,426,950		15,372,900		15,431,190	

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table X-10

POLLUTANT REDUCTION BENEFITS - DIRECT DISCHARGERS ROLLING WITH EMULSIONS SUBCATEGORY

	Pollutant	Raw Waste	Option 1*		Option 2	
	Flow (l/yr)	29.58 x 10^9	8.934 x 10^9		7.336 x 10^9	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	52.5	0.0	52.5	0.0	52.5
119.	Chromium	4,085.5	3,392.0	693.5	3,501.0	584.5
120.	Copper	3,745.1	0.0	3,745.1	0.0	3,745.1
121.	Cyanide	225.7	0.0	225.7	0.0	225.7
122.	Lead	13,006.9	11,961.4	1,045.5	12,124.9	882.0
124.	Nickel	573.2	0.0	573.2	0.0	573.2
128.	Zinc	8,372.6	5,772.1	2,600.5	6,180.8	2,191.8
	Aluminum	241,435.0	230,457.8	10,977.2	231,969.9	9,465.2
	Oil and Grease	6,801,024.0	6,710,883.0	90,141.0	6,724,504.8	76,519.2
	TSS	3,865,381.6	3,758,166.4	107,215.2	3,774,512.6	90,869.0
	Total Toxic Organics	10,201.5	10,066.3	135.2	10,086.8	114.8
	Total Toxic Metals	29,835.8	21,125.5	8,710.3	21,806.7	8,029.1
	Total Toxics	40,263.0	31,191.8	9,071.2	31,893.5	8,369.6
	Total Conventionals	10,666,405.6	10,469,049.4	197,356.2	10,499,017.4	167,388.2
	Total Pollutants	10,948,103.6	10,730,699.0	217,404.6	10,762,880.8	185,223.0
	Sludge	-----	59,063,040		59,262,050	

*Option 1 is BAT=BPT

Table X-10 (Continued)

POLLUTANT REDUCTION BENEFITS - DIRECT DISCHARGERS
ROLLING WITH EMULSIONS SUBCATEGORY

	Pollutant	Option 3		Option 4		Option 5	
	Flow (l/yr)	7.336×10^9		7.032×10^9		7.032×10^9	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	52.5	0.0	52.5	0.0	52.5
119.	Chromium	3,574.1	511.4	3,525.4	560.1	3,595.4	490.1
120.	Copper	893.0	2,852.0	0.0	3,745.1	1,011.8	2,733.3
121.	Cyanide	0.0	225.7	0.0	225.7	0.0	225.7
122.	Lead	12,417.1	589.8	12,161.4	845.5	12,441.5	565.4
124.	Nickel	0.0	573.2	0.0	573.2	0.0	573.2
128.	Zinc	6,692.2	1,680.4	6,272.1	2,100.5	6,762.2	1,610.4
	Aluminum	234,673.1	6,761.9	232,307.8	9,127.3	234,898.4	6,536.6
	Oil and Grease	6,724,504.8	76,519.2	6,727,548.9	73,475.1	6,727,548.9	73,475.1
	TSS	3,843,190.3	22,191.4	3,778,165.5	87,216.1	3,843,981.7	21,399.9
	Total Toxic Organics	10,086.8	114.8	10,091.3	110.2	10,091.3	110.2
	Total Toxic Metals	23,576.4	6,259.3	21,958.9	7,876.9	23,810.9	6,024.9
	Total Toxics	33,663.2	6,599.8	32,050.2	8,212.8	33,902.2	6,360.8
	Total Conventionals	10,567,695.1	98,710.6	10,505,714.4	160,691.2	10,571,530.6	94,875.0
	Total Pollutants	10,836,031.4	112,072.3	10,770,072.4	178,031.3	10,840,331.2	107,772.4
	Sludge	59,697,730		59,306,530		59,726,360	

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table X-11

POLLUTANT REDUCTION BENEFITS - DIRECT DISCHARGERS
EXTRUSION SUBCATEGORY

	Pollutant	Raw Waste	Option 1*		Option 2	
	Flow (l/yr)	13.43×10^9	10.58×10^9		2.870×10^9	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	46.2	0.0	46.2	0.0	46.2
119.	Chromium	66,671.8	66,120.6	551.2	66,547.0	124.8
120.	Copper	7,660.4	1,980.5	5,679.9	6,143.4	1,517.0
121.	Cyanide	708.5	16.4	692.1	519.3	189.2
122.	Lead	2,751.5	1,567.0	1,184.3	2,425.6	325.7
124.	Nickel	3,845.0	0.0	3,845.0	2,356.6	1,488.4
128.	Zinc	11,170.3	8,261.6	2,908.7	10,398.5	771.8
	Aluminum	1,153,240.6	1,142,594.3	10,646.3	1,148,005.4	5,235.2
	Oil and Grease	383,016.3	276,406.7	106,609.6	347,635.8	35,380.5
	TSS	1,456,156.1	1,334,410.4	121,745.7	1,417,635.1	38,521.0
	Total Toxic Organics	574.6	414.6	160.0	521.4	53.2
	Total Toxic Metals	92,145.1	77,929.7	14,215.4	87,871.1	4,274.0
	Total Toxics	93,428.1	78,360.7	15,067.4	88,911.8	4,516.3
	Total Conventionals	1,839,172.4	1,610,817.1	228,355.3	1,765,270.9	73,901.5
	Total Pollutants	3,085,841.2	2,831,772.1	254,069.1	3,002,188.1	83,653.1
	Sludge	-----	46,736,230		47,899,710	

*Option 1 is BAT=BPT

Table X-11 (Continued)

POLLUTANT REDUCTION BENEFITS - DIRECT DISCHARGERS
EXTRUSION SUBCATEGORY

	Pollutant	Option 3		Option 4*		Option 5*	
	Flow (l/yr)	2.870×10^9		2.804×10^9		2.804×10^9	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	46.2	0.0	45.2	0.0	45.2
119.	Chromium	66,573.3	98.5	65,076.6	204.7	65,102.2	179.1
120.	Copper	6,641.1	1,019.3	6,009.4	1,491.3	6,495.6	1,005.1
121.	Cyanide	579.5	129.0	508.0	185.6	566.9	126.8
122.	Lead	2,530.4	220.9	2,372.4	321.6	2,474.8	219.2
124.	Nickel	3,273.5	571.5	2,306.4	1,458.4	3,201.9	562.9
128	Zinc	10,582.0	588.3	10,169.7	767.6	10,348.8	588.5
	Aluminum	1,148,974.7	4,265.9	1,122,637.5	6,551.5	1,123,584.2	5,604.8
	Oil and Grease	347,635.8	35,380.5	339,985.1	35,043.2	339,985.1	35,043.2
	TSS	1,442,260.3	13,895.8	1,386,343.2	39,443.7	1,410,393.9	15,393.0
	Total Toxic Organics	521.4	53.2	510.0	52.6	510.0	52.6
	Total Toxic Metals	89,600.3	2,544.8	85,934.5	4,288.8	87,623.3	2,600.0
	Total Toxics	90,701.2	2,726.9	86,952.5	4,527.0	88,700.2	2,779.4
	Total Conventionals	1,789,896.2	49,276.2	1,726,328.3	74,486.9	1,750,379.0	50,436.2
	Total Pollutants	3,029,572.1	56,269.1	2,935,918.3	85,565.4	2,962,663.4	58,820.4
	Sludge	48,008,840		41,200,270		41,389,170	

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

*Benefits for Options 4 and 5 were not revised for promulgation.

Table X-12

POLLUTANT REDUCTION BENEFITS - DIRECT DISCHARGERS
DRAWING WITH NEAT OILS SUBCATEGORY

	Pollutant	Raw Waste	Option 1*		Option 2	
	Flow (l/yr)	1.770 x 10^9	1.770 x 10^9		268.8 x 10^6	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	9.4	0.0	9.4	0.0	9.4
119.	Chromium	2,626.5	2,534.7	91.9	2,610.6	15.9
120.	Copper	2,484.8	1,812.4	672.4	2,363.1	121.7
121.	Cyanide	19.0	0.0	19.0	0.0	19.0
122.	Lead	1,019.8	869.5	150.2	983.5	36.3
124.	Nickel	417.2	0.0	417.2	303.8	113.5
128.	Zinc	5,106.8	4,762.3	344.6	5,047.1	59.7
	Aluminum	306,418.4	301,972.9	4,445.5	303,026.9	3,391.6
	Oil and Grease	38,901.4	19,326.8	19,574.5	28,821.9	10,079.5
	TSS	226,144.6	204,886.9	21,257.7	216,280.9	9,863.7
	Total Toxic Organics	58.4	29.0	29.4	43.2	15.1
	Total Toxic Metals	11,664.5	9,978.9	1,685.7	11,308.1	356.5
	Total Toxics	11,741.9	10,007.9	1,734.1	11,351.3	390.6
	Total Conventionals	265,046.0	224,213.7	40,832.2	245,102.8	19,943.2
	Total Pollutants	583,206.3	536,194.5	47,011.8	559,481.0	23,725.4
	Sludge	-----	9,712,050		9,866,490	

*Option 1 is BAT=BPT

Table X-12 (Continued)

POLLUTANT REDUCTION BENEFITS - DIRECT DISCHARGERS
DRAWING WITH NEAT OILS SUBCATEGORY

	Pollutant	Option 3		Option 4		Option 5	
	Flow (l/yr)	268.8×10^6		268.4×10^6		268.4×10^6	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	9.4	0.0	9.4	0.0	9.4
119.	Chromium	2,612.6	13.9	2,610.7	15.9	2,612.6	13.9
120.	Copper	2,401.0	83.8	2,363.4	121.4	2,401.1	83.7
121.	Cyanide	4.0	15.0	0.0	19.0	4.0	14.9
122.	Lead	991.4	28.3	983.5	36.3	991.5	28.3
124.	Nickel	373.4	43.8	304.0	113.2	373.5	43.7
128.	Zinc	5,061.0	45.8	5,047.2	59.6	5,061.1	45.7
	Aluminum	303,100.5	3,317.9	303,027.4	3,391.0	303,100.9	3,317.6
	Oil and Grease	28,821.9	10,079.5	28,826.6	10,074.8	28,826.6	10,074.8
	TSS	218,151.9	7,992.7	216,286.6	9,858.0	218,153.2	7,991.5
	Total Toxic Organics	43.2	15.1	43.2	15.1	43.2	15.1
	Total Toxic Metals	11,439.4	225.0	11,308.8	355.8	11,439.8	224.7
	Total Toxics	11,486.6	255.1	11,352.0	389.9	11,487.0	254.7
	Total Conventionals	246,973.8	18,072.2	245,113.2	19,932.8	246,979.8	18,066.3
	Total Pollutants	561,560.9	21,645.2	559,492.6	23,713.7	561,567.7	21,638.6
	Sludge	9,881,160		9,866,570		9,881,210	

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table X-13

POLLUTANT REDUCTION BENEFITS - DIRECT DISCHARGERS DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

	Pollutant	Raw Waste	Option 1*		Option 2	
	Flow (l/yr)	271.3 x 10^6	271.3 x 10^6		79.62 x 10^6	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.4	0.0	0.4	0.0	0.4
119.	Chromium	480.8	459.1	21.7	474.4	6.4
120.	Copper	21.9	0.0	21.9	0.0	21.9
121.	Cyanide	1.8	0.0	1.8	0.0	1.8
122.	Lead	36.9	4.3	32.6	27.3	9.6
124.	Nickel	6.2	0.0	6.2	0.0	6.2
128.	Zinc	28.6	0.0	28.6	4.7	23.9
	Aluminum	289.8	0.0	289.8	201.4	88.4
	Oil and Grease	51,542.6	48,829.4	2,713.2	50,746.4	796.2
	TSS	6,926.7	3,670.9	3,255.8	5,971.3	955.4
	Total Toxic Organics	77.3	73.2	4.1	76.1	1.2
	Total Toxic Metals	574.8	463.4	111.4	506.4	68.4
	Total Toxics	653.9	536.6	117.3	582.5	71.4
	Total Conventionals	58,469.3	52,500.3	5,969.0	56,717.7	1,751.6
	Total Pollutants	59,413.0	53,036.9	6,376.1	57,501.6	1,911.4
	Sludge	-----	267,560		294,800	

*Option 1 is BAT-BPT

Table X-13 (Continued)

POLLUTANT REDUCTION BENEFITS - DIRECT DISCHARGERS
DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

	Pollutant	Option 3		Option 4		Option 5	
	Flow (l/yr)	79.62×10^6		68.97×10^6		68.97×10^6	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	0.4	0.0	0.4	0.0	0.4
119.	Chromium	475.2	5.6	475.3	5.5	476.0	4.8
120.	Copper	0.0	21.9	0.0	21.9	0.0	21.9
121.	Cyanide	0.0	1.8	0.0	1.8	0.0	1.8
122.	Lead	30.5	6.4	28.6	8.3	31.4	5.5
124.	Nickel	0.0	6.2	0.0	6.2	0.0	6.2
128.	Zinc	10.3	18.3	7.9	20.7	12.7	15.9
	Aluminum	230.9	58.9	213.3	76.6	238.8	51.0
	Oil and Grease	50,746.4	796.2	50,852.9	689.7	50,852.9	689.7
	TSS	6,719.7	207.0	6,099.1	827.7	6,747.4	179.3
	Total Toxic Organics	76.1	1.2	76.3	1.0	76.3	1.0
	Total Toxic Metals	516.0	58.8	511.8	63.0	520.1	54.7
	Total Toxics	592.1	61.8	588.1	65.8	596.4	57.5
	Total Conventionals	57,466.1	1,003.2	56,952.0	1,517.4	57,600.3	869.0
	Total Pollutants	58,289.1	1,123.9	57,753.4	1,659.8	58,435.5	977.5
	Sludge	299,470		296,360		300,400	

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table X-14

POLLUTANT REDUCTION BENEFITS - NORMAL PLANT ROLLING WITH NEAT OILS SUBCATEGORY

Pollutant	Raw Waste (kg/yr)	Option 1 Removed (kg/yr)	Option 1 Discharged (kg/yr)	Option 2 Removed (kg/yr)	Option 2 Discharged (kg/yr)	Option 3 Removed (kg/yr)	Option 3 Discharged (kg/yr)
118. cadmium	.67	.00	.67	.00	.67	.00	.67
119. chromium	306.99	294.55	12.44	303.93	3.07	304.31	2.68
120. copper	130.05	40.97	89.08	107.57	22.48	114.84	15.21
121. cyanide	1.61	.00	1.61	.00	1.61	.00	1.61
122. lead	83.78	64.54	19.24	78.60	5.18	80.13	3.65
124. nickel	22.76	.00	22.76	1.68	21.07	14.49	8.27
128. zinc	256.35	209.71	46.64	244.87	11.47	247.55	8.80
aluminum	14,759.91	14,524.19	235.73	14,567.33	192.58	14,581.49	178.43
oil and grease	43,959.49	42,021.90	1,937.59	43,194.00	765.50	43,194.00	765.50
TSS	16,397.70	14,178.25	2,219.45	15,584.75	812.94	15,944.31	453.39
total toxic organics	65.94	63.03	2.90	64.79	1.15	64.79	1.15
total toxic metals	800.60	609.77	190.83	736.66	63.94	761.33	39.27
total toxics	868.14	672.80	195.34	801.45	66.70	826.12	42.03
total conventionals	60,357.19	56,200.15	4,157.03	58,778.75	1,578.44	59,138.30	1,218.88
total pollutants	75,985.24	71,397.14	4,588.10	74,147.53	1,837.72	74,545.91	1,439.33
sludge		695,817.39		711,117.39		713,886.96	
flow (000's l/yr)	184,908.70	184,908.70		41,562.61		41,562.61	

Table X-15

POLLUTANT REDUCTION BENEFITS - NORMAL PLANT
ROLLING WITH EMULSIONS SUBCATEGORY

		Option 1		Option 2		Option 3	
Pollutant	Raw Waste (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118. cadmium	2.39	.00	2.30	.00	2.39	.00	2.39
119. chromium	201.05	169.06	32.00	174.50	26.55	177.82	23.23
120. copper	173.00	.00	173.00	.97	172.03	43.41	129.59
121. cyanide	10.23	.00	10.23	.00	10.23	.00	10.23
122. lead	588.73	540.49	48.25	548.65	40.09	561.92	26.81
124. nickel	26.61	.00	26.61	.00	26.61	.00	26.61
128. zinc	385.78	265.81	119.97	286.20	99.58	309.44	76.35
aluminum	11,333.47	10,823.90	509.57	10,899.34	434.13	11,022.16	311.31
oil and grease	307,201.16	303,034.50	4,166.66	303,714.16	3,487.00	303,714.16	3,487.00
TSS	174,876.59	169,922.81	4,953.78	170,738.09	4,138.50	173,858.71	1,017.88
total toxic organics	460.80	454.55	6.25	455.58	5.23	455.58	5.23
total toxic metals	1,377.58	975.36	402.22	1,010.32	367.25	1,092.59	284.99
total toxics	1,848.61	1,429.91	418.70	1,465.90	382.71	1,548.16	300.45
total conventionals	482,077.75	472,957.30	9,120.44	474,452.25	7,625.50	477,572.88	4,504.87
total pollutants	495,259.82	485,211.11	10,048.71	486,817.49	8,442.33	490,143.20	5,116.63
sludge		2,680,100.00		2,690,037.92		2,709,848.33	
flow (000's l/yr)	1,344,833.33	412,787.50		333,391.67		333,391.67	

Table X-16

POLLUTANT REDUCTION BENEFITS - NORMAL PLANT
EXTRUSION SUBCATEGORY

Pollutant	Raw Waste (kg/yr)	Option 1 Removed (kg/yr)	Option 1 Discharged (kg/yr)	Option 2 Removed (kg/yr)	Option 2 Discharged (kg/yr)	Option 3 Removed (kg/yr)	Option 3 Discharged (kg/yr)
118. cadmium	.79	.00	.79	.00	.79	.00	.79
119. chromium	1,727.57	1,717.45	10.11	1,725.11	2.45	1,725.54	2.03
120. copper	124.60	32.50	92.10	100.03	24.57	108.09	16.51
121. cyanide	19.21	7.98	11.23	16.17	3.04	17.14	2.07
122. lead	44.03	24.81	19.22	38.77	5.25	40.47	3.56
124. nickel	63.53	.00	63.53	39.41	24.12	54.27	9.26
128. zinc	194.47	146.99	47.47	181.97	12.50	184.94	9.53
aluminum	19,008.56	18,801.31	207.25	18,930.12	78.44	18,945.82	62.74
oil and grease	6,274.03	4,553.70	1,720.34	5,717.87	556.16	5,717.87	556.16
TSS	23,465.16	21,461.55	2,003.61	22,855.87	609.28	23,254.49	210.67
total toxic organics	9.41	6.83	2.58	8.58	.83	8.58	.83
total toxic metals	2,154.98	1,921.76	233.22	2,085.30	69.68	2,113.31	41.67
total toxics	2,183.60	1,936.57	247.03	2,110.04	73.56	2,139.03	44.57
total conventionals	29,737.19	26,015.24	3,723.94	28,573.74	1,165.45	28,972.36	766.83
total pollutants	50,931.35	46,753.13	4,178.23	49,613.90	1,317.45	50,057.22	874.14
sludge		1,026,918.11		1,046,264.22		1,049,574.33	
flow (000's l/yr)	216,777.78	169,666.67		46,555.56		46,555.56	

Table X-17

POLLUTANT REDUCTION BENEFITS - NORMAL PLANT
FORGING SUBCATEGORY

Pollutant	Raw Waste (kg/yr)	Option 1 Removed (kg/yr)	Option 1 Discharged (kg/yr)	Option 2 Removed (kg/yr)	Option 2 Discharged (kg/yr)	Option 3 Removed (kg/yr)	Option 3 Discharged (kg/yr)
118. cadmium	1.08	.00	1.08	.00	1.08	.34	.73
119. chromium	356.91	348.37	8.54	355.71	1.20	355.86	1.05
120. copper	292.93	230.29	62.63	283.47	9.46	286.33	6.60
121. cyanide	3.34	.00	3.34	1.63	1.72	1.97	1.38
122. lead	129.60	115.32	14.28	126.32	3.28	126.92	2.68
124. nickel	48.78	.00	48.78	40.22	8.57	45.48	3.31
128. zinc	607.73	575.72	32.02	603.23	4.51	604.28	3.46
aluminum	36,425.67	35,930.80	494.87	36,032.58	393.09	36,038.13	387.53
oil and grease	3,771.88	1,744.41	2,027.48	2,661.29	1,110.59	2,661.29	1,110.59
TSS	26,356.02	24,187.99	2,168.03	25,288.25	1,067.77	25,429.52	926.50
total toxic organics	6.89	2.62	4.28	3.99	2.90	3.99	2.90
total toxic metals	1,437.03	1,269.69	167.33	1,408.93	28.09	1,419.19	17.83
total toxics	1,447.26	1,272.31	174.95	1,414.55	32.71	1,425.15	22.11
total conventionals	30,127.90	25,932.40	4,195.50	27,949.54	2,178.36	28,090.81	2,037.09
total pollutants	68,000.83	63,135.51	4,865.32	65,396.67	2,604.16	65,554.09	2,446.73
sludge		1,152,731.67		1,168,102.50		1,169,214.17	
flow (000's l/yr)	180,500.00	180,500.00		23,316.67		23,316.67	

Table X-18

POLLUTANT REDUCTION BENEFITS - NORMAL PLANT
DRAWING WITH NEAT OILS SUBCATEGORY

Pollutant	Raw Waste (kg/yr)	Option 1 Removed (kg/yr)	Option 1 Discharged (kg/yr)	Option 2 Removed (kg/yr)	Option 2 Discharged (kg/yr)	Option 3 Removed (kg/yr)	Option 3 Discharged (kg/yr)
118. cadmium	.63	.00	.63	.00	.63	.02	.61
119. chromium	392.14	386.14	6.01	391.12	1.03	391.25	.90
120. copper	165.14	121.18	43.96	157.30	7.84	159.74	5.40
121. cyanide	3.90	1.63	2.28	2.66	1.24	2.93	.98
122. lead	67.96	58.13	9.84	65.60	2.36	66.11	1.85
124. nickel	27.78	.00	27.78	20.49	7.29	24.97	2.82
128. zinc	346.46	323.94	22.52	342.62	3.84	343.52	2.95
aluminum	20,492.12	20,198.17	293.96	20,267.30	224.82	20,272.03	220.09
oil and grease	2,608.77	1,320.59	1,288.19	1,943.39	665.38	1,943.39	665.38
TSS	15,175.50	13,777.96	1,397.54	14,525.32	650.18	14,645.58	529.92
total toxic organics	3.92	1.98	1.94	2.92	1.00	2.92	1.00
total toxic metals	1,000.11	889.38	110.73	977.13	22.98	985.59	14.52
total toxics	1,007.92	892.99	114.94	982.70	25.22	991.43	16.49
total conventionals	17,784.27	15,098.55	2,685.73	16,468.71	1,315.56	16,588.97	1,195.30
total pollutants	39,284.31	36,189.70	3,094.62	37,718.71	1,565.60	37,852.43	1,431.88
sludge		652,587.50		662,777.00		663,720.50	
flow (000's l/yr)	116,370.00	116,370.00		17,429.00		17,429.00	

Table X-19

POLLUTANT REDUCTION BENEFITS - NORMAL PLANT DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Pollutant	Raw Waste (kg/yr)	Option 1 Removed (kg/yr)	Option 1 Discharged (kg/yr)	Option 2 Removed (kg/yr)	Option 2 Discharged (kg/yr)	Option 3 Removed (kg/yr)	Option 3 Discharged (kg/yr)
118. cadmium	.22	.00	.22	.00	.22	.00	.22
119. chromium	136.56	130.76	5.80	135.00	1.56	135.18	1.38
120. copper	39.40	24.34	15.06	32.76	6.64	33.48	5.92
121. cyanide	.64	.00	.64	.00	.64	.02	.62
122. lead	22.80	13.90	8.90	20.24	2.56	21.04	1.76
124. nickel	7.12	.00	7.12	3.76	3.36	5.06	2.06
128. zinc	77.32	66.14	11.18	71.42	5.90	72.80	4.52
aluminum	4,342.30	4,219.82	122.48	4,276.22	66.08	4,283.50	58.80
oil and grease	12,667.16	11,829.08	838.08	12,357.66	309.50	12,357.66	309.50
TSS	4,706.94	3,732.40	974.54	4,366.68	340.26	4,551.50	155.44
total toxic organics	19.00	17.74	1.26	18.54	.46	18.54	.46
total toxic metals	283.42	235.14	48.28	263.18	20.24	267.56	15.86
total toxics	303.06	252.88	50.18	281.72	21.34	286.12	16.94
total conventionals	17,374.10	15,561.48	1,812.62	16,724.34	649.76	16,909.16	464.94
total pollutants	22,019.46	20,034.18	1,985.28	21,282.28	737.18	21,478.78	540.68
sludge		198,908.00		206,686.00		207,892.00	
flow (000's l/yr)	81,200.00	81,200.00		20,636.00		20,636.00	

Table X-20

ROLLING WITH NEAT OILS SUBCATEGORY
TREATMENT PERFORMANCE - NORMAL PLANT

Pollutant		Combined Raw Waste		Option 1		Option 2		Option 3	
Flow l/kkg		1,109		1,109		249		249	
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
118.	Cadmium	0.004	0.004	0.004	0.004	0.02	0.005	0.02	0.005
119.	Chromium	1.66	1.84	0.08	0.09	0.08	0.02	0.07	0.02
120.	Copper	0.70	0.78	0.58	0.64	0.58	0.14	0.39	0.10
121.	Cyanide	0.01	0.01	0.01	0.01	0.04	0.01	0.04	0.01
122.	Lead	0.45	0.50	0.12	0.13	0.12	0.03	0.08	0.02
124.	Nickel	0.12	0.13	0.12	0.13	0.57	0.14	0.22	0.05
128.	Zinc	1.39	1.54	0.30	0.33	0.30	0.07	0.23	0.06
	Aluminum	79.82	88.52	2.24	2.48	2.24	0.56	1.49	0.37
	Oil and Grease	237.73	263.64	10.00	11.09	10.00	2.49	10.00	24.90
	TSS	88.68	98.35	12.00	13.31	12.00	2.99	2.6	0.65

Table X-21

ROLLING WITH EMULSIONS SUBCATEGORY
TREATMENT PERFORMANCE - NORMAL PLANT

Pollutant		Combined Raw Waste		Option 1		Option 2		Option 3	
Flow l/kkg		8,963		2,751		2,222		2,222	
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
118.	Cadmium	0.002	0.02	0.06	0.02	0.01	0.02	0.01	0.02
119.	Chromium	0.15	1.34	0.08	0.22	0.08	0.18	0.07	0.16
120.	Copper	0.13	1.17	0.42	1.17	0.58	1.29	0.39	0.87
121.	Cyanide	0.01	0.09	0.02	0.09	0.03	0.09	0.03	0.09
122.	Lead	0.44	3.94	0.12	0.33	0.12	0.27	0.08	0.18
124.	Nickel	0.02	0.18	0.06	0.18	0.08	0.18	0.08	0.18
128.	Zinc	0.29	2.60	0.30	0.83	0.30	0.67	0.23	0.51
	Aluminum	8.49	76.10	2.24	6.16	2.24	4.98	1.49	3.31
	Oil and Grease	230.14	2062.74	10.00	27.51	10.00	22.22	10.00	22.22
	TSS	131.01	1174.24	12.00	33.01	12.00	26.66	2.6	5.78

Table X-22

EXTRUSION SUBCATEGORY
TREATMENT PERFORMANCE - NORMAL PLANT

Pollutant	Combined Raw Waste		Option 1		Option 2		Option 3	
Flow l/kkg	11,300		8,845		2,427		2,427	
	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
118. Cadmium	0.004	0.05	0.005	0.05	0.02	0.05	0.02	0.05
119. Chromium	7.97	90.06	0.08	0.71	0.08	0.19	0.07	0.17
120. Copper	0.57	6.44	0.58	5.13	0.58	1.41	0.39	0.95
121. Cyanide	0.09	1.02	0.07	0.62	0.07	0.17	0.047	0.11
122. Lead	0.20	2.26	0.12	1.06	0.12	0.29	0.08	0.19
124. Nickel	0.29	3.28	0.37	3.28	0.57	1.38	0.22	0.53
128. Zinc	0.90	10.17	0.30	2.65	0.30	0.27	0.23	0.56
Aluminum	87.69	990.90	2.24	19.81	2.24	5.44	1.49	3.62
Oil and Grease	28.94	327.02	10.00	88.45	10.00	24.27	10.00	24.27
TSS	108.24	1223.11	12.00	106.14	12.00	29.12	2.6	6.31

Table X-23

FORGING SUBCATEGORY
TREATMENT PERFORMANCE - NORMAL PLANT

Pollutant	Combined Raw Waste		Option 1		Option 2		Option 3	
Flow l/kkg	37,660		37,660		4,865		4,865	
	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
118. Cadmium	0.01	0.38	0.01	0.38	0.05	0.38	0.049	0.24
119. Chromium	1.98	74.57	0.08	3.01	0.08	0.39	0.07	0.34
120. Copper	1.62	61.01	0.58	21.84	0.58	2.82	0.39	1.89
121. Cyanide	0.02	0.75	0.02	0.75	0.07	0.34	0.047	0.23
122. Lead	0.72	27.12	0.12	4.52	0.12	0.58	0.08	0.39
124. Nickel	0.27	10.17	0.27	10.17	0.57	2.77	0.22	1.07
128. Zinc	3.37	126.91	0.30	11.30	0.30	1.46	0.23	1.12
Aluminum	201.80	7599.79	2.24	84.36	2.24	10.90	1.49	7.25
Oil and Grease	20.90	787.09	10.00	376.60	10.00	48.65	10.00	48.65
TSS	146.02	5499.11	12.00	451.92	12.00	58.38	2.6	12.65

Table X-24

DRAWING WITH NEAT OILS SUBCATEGORY
TREATMENT PERFORMANCE - NORMAL PLANT

Pollutant	Combined Raw Waste		Option 1		Option 2		Option 3	
Flow l/kkg	7,176		7,176		1,075		1,075	
	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
118. Cadmium	0.01	0.07	0.01	0.07	0.04	0.07	0.03	0.03
119. Chromium	3.37	24.18	0.08	0.57	0.08	0.086	0.07	0.08
120. Copper	1.42	10.19	0.58	4.16	0.58	0.62	0.39	0.42
121. Cyanide	0.03	0.22	0.02	0.14	0.07	0.08	0.047	0.05
122. Lead	0.58	4.16	0.12	0.86	0.12	0.13	0.08	0.09
124. Nickel	0.24	1.72	0.24	1.72	0.57	0.61	0.22	0.17
128. Zinc	2.98	21.38	0.30	2.15	0.30	0.32	0.23	0.25
Aluminum	176.09	1263.62	2.24	16.07	2.24	2.41	1.49	1.60
Oil and Grease	22.42	160.89	10.00	71.76	10.00	10.75	10.00	10.75
TSS	130.41	935.82	12.00	86.11	12.00	416.40	2.6	2.80

Table X-25

DRAWING WITH EMULSIONS SUBCATEGORY
TREATMENT PERFORMANCE - NORMAL PLANT

Pollutant		Combined Raw Waste		Option 1		Option 2		Option 3	
Flow l/kkg		11,740		11,740		2,985		2,985	
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
118.	Cadmium	0.003	0.04	0.003	0.04	0.01	0.04	0.01	0.04
119.	Chromium	1.68	19.72	0.08	0.94	0.08	0.24	0.07	0.21
120.	Copper	0.49	5.75	0.19	2.23	0.32	0.96	0.29	0.87
121.	Cyanide	0.01	0.12	0.01	0.12	0.03	0.12	0.03	0.12
122.	Lead	0.28	3.29	0.12	1.41	0.12	0.36	0.08	0.24
124.	Nickel	0.09	1.06	0.09	1.06	0.16	0.48	0.10	0.30
128.	Zinc	0.95	11.15	0.30	3.52	0.30	0.90	0.23	0.69
	Aluminum	53.48	627.86	2.24	26.30	2.24	6.69	1.49	4.45
	Oil and Grease	156.00	2073.24	10.00	117.40	10.00	29.85	10.00	29.85
	TSS	57.97	680.57	12.00	140.88	12.00	35.82	2.60	7.76

Table X-26

TTO - EVALUATION OF OIL TREATMENT EFFECTIVENESS ON TOXICS REMOVAL

Pollutant Parameter		Influent Concentration (mg/l)	Effluent Concentration (mg/l)
001	acenaphthene	5.7	ND
038	ethylbenzene	0.089	0.01
055	naphthalene	0.75	0.23
062	N-nitrosodiphenylamine	1.5	0.091
065	phenol	0.18	0.04
066	bis(2-ethylhexyl)phthalate	1.25	0.01
068	di-n-butyl phthalate	1.27	0.019
078/081	anthracene/phenanthrene	2.0	0.1
080	fluorene	0.76	0.035
084	pyrene	0.075	0.01
085	tetrachloroethylene	4.2	0.1
086	toluene	0.16	0.02
087	trichloroethylene	4.8	0.01
097	endosulfan sulfate	0.012	ND
098	endrin	0.066	0.005
107	PCB-1254 (a)	1.1	0.005
110	PCB-1248 (b)	1.8	0.005
	(mg/l)	25.7	0.690

a: PBC-1242, PCB-1254, PCB-1221, PCB-1232 reported together.

b: PBC-1248, PCB-1260, PCB-1016 reported together.

Table X-27

PRODUCTION OPERATIONS - ROLLING WITH NEAT OILS SUBCATEGORY

Operation	Waste Stream	Normalized BAT Discharge		Production Normalizing Parameter
		l/kkg	(gpt)	
Core				
Rolling with neat oils	Spent lubricant	0	(0)	
Roll grinding	Spent emulsion	5.5	(1.32)	Mass of aluminum rolled with neat oil
Stationary casting	None	0	(0)	
Homogenizing	None	0	(0)	
Artificial aging	None	0	(0)	
Degreasing	Spent solvents	0	(0)	
Sawing	Spent lubricant	4.807	(1.153)	Mass of aluminum rolled with neat oil
Miscellaneous nondescript wastewater sources	Various	45	(10.80)	Mass of aluminum rolled with neat oil
	Total core without an annealing furnace scrubber	55.307	(13.27)	
Annealing	Atmosphere scrubber liquor	26.35	(6.320)	Mass of aluminum rolled with neat oil
	Total core with an annealing furnace scrubber	81.66	(19.60)	

Table X-27 (Continued)

PRODUCTION OPERATIONS - ROLLING WITH NEAT OILS SUBCATEGORY

Operation	Waste Stream	Normalized BAT Discharge 1/kkg	Normalized BAT Discharge (gpt)	Production Normalizing Parameter
Ancillary				
Continuous sheet casting	Spent lubricant	1.964	(0.471)	Mass of aluminum cast by continuous methods
Solution heat treatment	Contact cooling water	2,037	(488.5)	Mass of aluminum quenched
Cleaning or etching	Bath	179	(42.96)	Mass of aluminum cleaned or etched
	Rinse	1,391	(333.8)	Mass of aluminum cleaned or etched
	Scrubber liquor	1,933	(463.5)	Mass of aluminum cleaned or etched

Table X-28

BAT MASS LIMITATIONS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Rolling With Neat Oils - Core Waste Streams Without An Annealing Furnace Scrubber

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum rolled with neat oils			
118	Cadmium	0.019	0.008
119	Chromium*	0.025	0.010
120	Copper	0.105	0.055
121	Cyanide*	0.016	0.0067
122	Lead	0.023	0.011
124	Nickel	0.106	0.070
125	Selenium	0.068	0.030
128	Zinc*	0.081	0.034
	Aluminum*	0.356	0.174
	Oil & Grease	1.106	0.664
	Total Suspended Solids	2.268	1.078
	pH	Within the range of 7.0 to 10.0 at all times.	

Rolling With Neat Oils - Core Waste Streams With An Annealing Furnace Scrubber

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum rolled with neat oils			
118	Cadmium	0.028	0.012
119	Chromium*	0.036	0.015
120	Copper	0.155	0.082
121	Cyanide*	0.024	0.0098
122	Lead	0.035	0.017
124	Nickel	0.157	0.104
125	Selenium	0.100	0.045
128	Zinc*	0.119	0.050
	Aluminum*	0.525	0.257
	Oil & Grease	1.633	0.980
	Total Suspended Solids	3.348	1.592
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-28 (Continued)

BAT MASS LIMITATIONS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Continuous Sheet Casting - Spent Lubricant

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.0007	0.0003
119 Chromium*	0.00086	0.00035
120 Copper	0.0037	0.0020
121 Cyanide*	0.00056	0.00024
122 Lead	0.0008	0.0004
124 Nickel	0.0038	0.0025
125 Selenium	0.0024	0.0011
128 Zinc*	0.00287	0.0012
Aluminum*	0.0127	0.0062
Oil & Grease	0.0393	0.0236
Total Suspended Solids	0.0805	0.0383
pH	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched		
118 Cadmium	0.693	0.306
119 Chromium*	0.897	0.367
120 Copper	3.870	2.037
121 Cyanide*	0.591	0.245
122 Lead	0.856	0.408
124 Nickel	3.911	2.587
125 Selenium	2.506	1.120
128 Zinc*	2.974	1.243
Aluminum*	13.098	6.518
Oil & Grease	40.740	24.444
Total Suspended Solids	83.517	39.722
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-28 (Continued)

BAT MASS LIMITATIONS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.262	0.109
	Aluminum*	1.151	0.573
	Oil & Grease	3.580	2.148
	Total Suspended Solids	7.339	3.491
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.473	0.209
119	Chromium*	0.612	0.251
120	Copper	2.643	1.391
121	Cyanide*	0.404	0.167
122	Lead	0.584	0.278
124	Nickel	2.671	1.767
125	Selenium	1.711	0.765
128	Zinc*	2.031	0.849
	Aluminum*	8.944	4.451
	Oil & Grease	27.820	16.692
	Total Suspended Solids	57.031	27.125
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-28 (Continued)

BAT MASS LIMITATIONS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched		
118 Cadmium	0.657	0.290
119 Chromium*	0.851	0.348
120 Copper	3.673	1.933
121 Cyanide*	0.561	0.232
122 Lead	0.812	0.387
124 Nickel	3.711	2.455
125 Selenium	2.378	1.063
128 Zinc*	2.822	1.179
Aluminum*	12.429	6.186
Oil & Grease	38.660	23.196
Total Suspended Solids	79.253	37.694
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-29

PRODUCTION OPERATIONS - ROLLING WITH EMULSIONS SUBCATEGORY

Operation	Waste Stream	Normalized BAT Discharge 1/kkg	Normalized BAT Discharge (gpt)	Production Normalizing Parameter
Core				
Rolling with emulsions	Spent emulsion	74.51	(17.87)	Mass of aluminum rolled with emulsions
Roll grinding	Spent emulsion	5.5	(1.32)	Mass of aluminum rolled with emulsions
Annealing	None	0	(0)	
Stationary casting	None	0	(0)	
Homogenizing	None	0	(0)	
Artificial aging	None	0	(0)	
Degreasing	None	0	(0)	
Sawing	Spent lubricant	4.807	(1.153)	Mass of aluminum rolled with emulsions
Miscellaneous nondescript wastewater sources	Various	45	(10.80)	Mass of aluminum rolled with emulsions
	Total Core	129.8	(31.16)	
Ancillary				
Direct chill casting	Contact cooling water	1,329	(318.9)	Mass of aluminum cast by direct chill method
Solution heat treatment	Contact cooling water	2,037	(488.5)	Mass of aluminum quenched
Cleaning or etching	Bath	179	(42.96)	Mass of aluminum cleaned or etched
	Rinse	1,391	(333.8)	Mass of aluminum cleaned or etched
	Scrubber Liquor	1,933	(463.5)	Mass of aluminum cleaned or etched

Table X-30

BAT MASS LIMITATIONS FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Rolling With Emulsions - Core Waste Streams

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum rolled with emulsions		
118	Cadmium	0.044	0.019
119	Chromium*	0.057	0.024
120	Copper	0.247	0.130
121	Cyanide*	0.038	0.016
122	Lead	0.055	0.026
124	Nickel	0.249	0.165
125	Selenium	0.160	0.071
128	Zinc*	0.190	0.079
	Aluminum*	0.835	0.415
	Oil & Grease	2.596	1.558
	Total Suspended Solids	5.323	2.531
	pH	Within the range of 7.0 to 10.0 at all times.	

Direct Chill Casting - Contact Cooling Water

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cast by direct chill methods		
118	Cadmium	0.452	0.199
119	Chromium*	0.585	0.239
120	Copper	2.525	1.329
121	Cyanide*	0.385	0.159
122	Lead	0.558	0.266
124	Nickel	2.552	1.688
125	Selenium	1.635	0.731
128	Zinc*	1.940	0.811
	Aluminum*	8.545	4.253
	Oil & Grease	26.580	15.948
	Total Suspended Solids	54.589	25.916
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-30 (Continued)

BAT MASS LIMITATIONS FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	0.693	0.306
119	Chromium*	0.896	0.367
120	Copper	3.870	2.037
121	Cyanide*	0.591	0.244
122	Lead	0.856	0.408
124	Nickel	3.911	2.587
125	Selenium	2.506	1.120
128	Zinc*	2.974	1.243
	Aluminum*	13.098	6.518
	Oil & Grease	40.740	24.444
	Total Suspended Solids	83.517	39.722
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.261	0.109
	Aluminum*	1.151	0.573
	Oil & Grease	3.580	2.148
	Total Suspended Solids	7.339	3.491
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-30 (Continued)

BAT MASS LIMITATIONS FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.473	0.209
119	Chromium*	0.612	0.250
120	Copper	2.643	1.391
121	Cyanide*	0.403	0.167
122	Lead	0.584	0.278
124	Nickel	2.671	1.767
125	Selenium	1.711	0.765
128	Zinc*	2.031	0.849
	Aluminum*	8.944	4.451
	Oil & Grease	27.820	16.692
	Total Suspended Solids	57.031	27.125
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.657	0.290
119	Chromium*	0.851	0.348
120	Copper	3.673	1.933
121	Cyanide*	0.561	0.232
122	Lead	0.812	0.387
124	Nickel	3.711	2.455
125	Selenium	2.378	1.063
128	Zinc*	2.822	1.179
	Aluminum*	12.429	6.186
	Oil & Grease	38.660	23.196
	Total Suspended Solids	79.253	37.694
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-31

PRODUCTION OPERATIONS - EXTRUSION SUBCATEGORY

Operation	Waste Stream	Normalized BAT Discharge 1/kkg	(gpt)	Production Normalizing Parameter
Core				
Extrusion	Die cleaning bath and rinse	12.90	(3.096)	Mass of aluminum extruded
	Die cleaning scrubber liquor	275.5	(66.08)	Mass of aluminum extruded
	Dummy block cooling	0	(0)	
Annealing	None	0	(0)	
Stationary casting	None	0	(0)	
Homogenizing	None	0	(0)	
Artificial aging	None	0	(0)	
Degreasing	Spent solvent	0	(0)	
Sawing	Spent lubricant	4.807	(1.153)	Mass of aluminum extruded
Miscellaneous nondescript wastewater sources	Various	45	(10.80)	Mass of aluminum extruded
	Total Core	340.1	(81.62)	
Ancillary				
Direct chill casting	Contact cooling water	1,329	(318.96)	Mass of aluminum cast by direct chill method
Extrusion press	Hydraulic fluid leakage	1,478	(354.7)	
Solution and press heat treatment	Contact cooling water	2,037	(488.5)	Mass of aluminum quenched
Cleaning or etching	Bath	179	(42.96)	Mass of aluminum cleaned or etched
	Rinse	1,391	(333.8)	Mass of aluminum cleaned or etched
	Scrubber liquor	1,933	(463.5)	Mass of aluminum cleaned or etched
Degassing	Scrubber liquor	0	(0)	Mass of aluminum degassed

Table X-32

BAT MASS LIMITATIONS FOR THE EXTRUSION SUBCATEGORY

Extrusion - Core Waste Streams

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum extruded			
118	Cadmium	0.116	0.051
119	Chromium*	0.150	0.061
120	Copper	0.646	0.340
121	Cyanide*	0.098	0.041
122	Lead	0.143	0.068
124	Nickel	0.653	0.432
125	Selenium	0.418	0.187
128	Zinc*	0.49	0.207
	Aluminum*	2.187	1.088
	Oil & Grease	6.802	4.081
	Total Suspended Solids	13.944	6.632
	pH	Within the range of 7.0 to 10.0 at all times.	

Direct Chill Casting - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by direct chill methods			
118	Cadmium	0.452	0.199
119	Chromium*	0.585	0.239
120	Copper	2.525	1.329
121	Cyanide*	0.385	0.159
122	Lead	0.558	0.266
124	Nickel	2.552	1.688
125	Selenium	1.635	0.731
128	Zinc*	1.940	0.811
	Aluminum*	8.545	4.253
	Oil & Grease	26.580	15.948
	Total Suspended Solids	54.489	25.916
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-32 (Continued)

BAT MASS LIMITATIONS FOR THE EXTRUSION SUBCATEGORY

Solution and Press Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	0.693	0.306
119	Chromium*	0.896	0.367
120	Copper	3.870	2.037
121	Cyanide*	0.591	0.244
122	Lead	0.856	0.408
124	Nickel	3.911	2.587
125	Selenium	2.506	1.120
128	Zinc*	2.974	1.243
	Aluminum*	13.098	6.518
	Oil & Grease	40.740	24.444
	Total Suspended Solids	83.517	39.722
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.262	0.109
	Aluminum*	1.151	0.573
	Oil & Grease	3.580	2.148
	Total Suspended Solids	7.339	3.491
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-32 (Continued)

BAT MASS LIMITATIONS FOR THE EXTRUSION SUBCATEGORY

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.473	0.209
119	Chromium*	0.612	0.250
120	Copper	2.643	1.391
121	Cyanide*	0.403	0.167
122	Lead	0.584	0.278
124	Nickel	2.671	0.278
125	Selenium	1.711	1.767
128	Zinc*	2.031	0.765
	Aluminum*	8.944	0.849
	Oil & Grease	27.820	4.451
	Total Suspended Solids	57.031	16.692
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.657	0.290
119	Chromium*	0.851	0.348
120	Copper	3.673	1.933
121	Cyanide*	0.561	0.232
122	Lead	0.812	0.387
124	Nickel	3.711	2.455
125	Selenium	2.378	1.063
128	Zinc*	2.822	1.179
	Aluminum*	12.429	6.186
	Oil & Grease	38.660	23.196
	Total Suspended Solids	79.253	37.694
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-32 (Continued)

BAT MASS LIMITATIONS FOR THE EXTRUSION SUBCATEGORY

Degassing - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum degassed		
118	Cadmium	0.00	0.00
119	Chromium*	0.00	0.00
120	Copper	0.00	0.00
121	Cyanide*	0.00	0.00
122	Lead	0.00	0.00
124	Nickel	0.00	0.00
125	Selenium	0.00	0.00
128	Zinc*	0.00	0.00
	Aluminum*	0.00	0.00
	Oil & Grease	0.00	0.00
	Total Suspended Solids	0.00	0.00
	pH	Within the range of 7.0 to 10.0 at all times.	

Extrusion Press Hydraulic Fluid Leakage

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum extruded		
118	Cadmium	0.503	0.222
119	Chromium*	0.650	0.266
120	Copper	2.808	1.478
121	Cyanide*	0.429	0.177
122	Lead	0.621	0.296
124	Nickel	2.838	1.877
125	Selenium	1.818	0.813
128	Zinc*	2.158	0.902
	Aluminum*	9.504	4.730
	Oil & Grease	29.560	17.736
	Total Suspended Solids	60.598	28.821
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-33

PRODUCTION OPERATIONS - FORGING SUBCATEGORY

Operation	Waste Stream	Normalized BAT Discharge 1/kkg	Normalized BAT Discharge (gpt)	Production Normalizing Parameter
Core				
Forging	None	0	(0)	
Annealing	None	0	(0)	
Artificial aging	None	0	(0)	
Degreasing	Spent solvent	0	(0)	
Sawing	Spent lubricant	4.807	(1.153)	Mass of aluminum forged
Miscellaneous nondescript wastewater sources	Various	45	(10.80)	Mass of aluminum forged
	Total Core	49.807	(11.95)	
Ancillary				
Forging	Scrubber liquor	94.31	(22.65)	Mass of aluminum forged
Solution heat treatment	Contact cooling water	2,037	(488.5)	Mass of aluminum quenched
Cleaning or etching	Bath	179	(42.96)	Mass of aluminum cleaned or etched
	Rinse	1,391	(333.8)	Mass of aluminum cleaned or etched
	Scrubber liquor	1,933	(463.5)	Mass of aluminum cleaned or etched

Table X-34

BAT MASS LIMITATIONS FOR THE FORGING SUBCATEGORY*

Forging - Core Waste Streams

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum forged		
118	Cadmium	0.017	0.007
119	Chromium	0.022	0.009
120	Copper	0.095	0.050
121	Cyanide	0.014	0.006
122	Lead	0.021	0.010
124	Nickel	0.096	0.063
125	Selenium	0.061	0.027
128	Zinc	0.073	0.030
	Aluminum	0.320	0.159
	Oil & Grease	0.996	0.598
	Total Suspended Solids	2.042	0.971
	pH	Within the range of 7.0 to 10.0 at all times.	

Forging - Scrubber Liquor

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum forged		
118	Cadmium	0.032	0.014
119	Chromium	0.042	0.017
120	Copper	0.179	0.094
121	Cyanide	0.027	0.011
122	Lead	0.040	0.019
124	Nickel	0.181	0.120
125	Selenium	0.116	0.052
128	Zinc	0.138	0.058
	Aluminum	0.606	0.302
	Oil & Grease	1.886	1.132
	Total Suspended Solids	3.867	1.839
	pH	Within the range of 7.0 to 10.0 at all times.	

*All of the pollutants shown in this table are not regulated at BAT since there are no existing forgers who are direct dischargers.

Table X-34 (Continued)

BAT MASS LIMITATIONS FOR THE FORGING SUBCATEGORY

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched		
118 Cadmium	0.693	0.306
119 Chromium	0.896	0.367
120 Copper	3.870	2.037
121 Cyanide	0.591	0.244
122 Lead	0.856	0.408
124 Nickel	3.911	2.587
125 Selenium	2.506	1.120
128 Zinc	2.974	1.243
Aluminum	13.098	6.518
Oil & Grease	40.740	24.444
Total Suspended Solids	83.517	39.722
pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched		
118 Cadmium	0.061	0.027
119 Chromium	0.079	0.032
120 Copper	0.340	0.179
121 Cyanide	0.052	0.021
122 Lead	0.075	0.036
124 Nickel	0.344	0.227
125 Selenium	0.220	0.098
128 Zinc	0.261	0.109
Aluminum	1.151	0.573
Oil & Grease	3.580	2.148
Total Suspended Solids	7.339	3.491
pH	Within the range of 7.0 to 10.0 at all times.	

Table X-34 (Continued)

BAT MASS LIMITATIONS FOR THE FORGING SUBCATEGORY

Cleaning or Etching - Rinse

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched		
118 Cadmium	0.473	0.209
119 Chromium	0.612	0.250
120 Copper	2.643	1.391
121 Cyanide	0.403	0.167
122 Lead	0.584	0.278
124 Nickel	2.671	1.767
125 Selenium	1.711	0.765
128 Zinc	2.031	0.849
Aluminum	8.944	4.451
Oil & Grease	27.820	16.692
Total Suspended Solids	57.031	27.125
pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched		
118 Cadmium	0.657	0.290
119 Chromium	0.851	0.348
120 Copper	3.673	1.933
121 Cyanide	0.561	0.232
122 Lead	0.812	0.387
124 Nickel	3.711	2.455
125 Selenium	2.378	1.063
128 Zinc	2.822	1.179
Aluminum	12.429	6.186
Oil & Grease	38.660	23.196
Total Suspended Solids	79.253	37.694
pH	Within the range of 7.0 to 10.0 at all times.	

Table X-35

PRODUCTION OPERATIONS - DRAWING WITH NEAT OILS SUBCATEGORY

Operation	Waste Stream	Normalized BAT Discharge 1/kkg	Normalized BAT Discharge (gpt)	Production Normalizing Parameter
Core				
Drawing with neat oils	Spent oils	0	(0)	
Annealing	None	0	(0)	
Stationary casting	None	0	(0)	
Homogenizing	None	0	(0)	
Artificial aging	None	0	(0)	
Degreasing	Spent solvent	0	(0)	
Sawing	Spent lubricant	4.807	(1.153)	Mass of aluminum drawn with neat oils
Swaging	None	0	(0)	
Miscellaneous nondescript wastewater sources	Various	45	(10.80)	Mass of aluminum drawn with neat oils
	Total Core	49.807	(11.95)	
Ancillary				
Continous rod casting	Contact cooling water	193.9	(46.54)	Mass of rod cast by continuous method
	Spent lubricant	1.964	(0.471)	Mass of rod cast by continuous method
Solution heat treatment	Contact cooling water	2,037	(488.5)	Mass of aluminum quenched
Cleaning or etching	Bath	179	(42.96)	Mass of aluminum cleaned or etched
	Rinse	1,391	(333.8)	Mass of aluminum cleaned or etched
	Scrubber liquor	1,933	(463.5)	Mass of aluminum cleaned or etched

Table X-36

BAT MASS LIMITATIONS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Drawing With Neat Oils - Core Waste Streams

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum drawn with neat oils		
118	Cadmium	0.017	0.007
119	Chromium*	0.022	0.009
120	Copper	0.097	0.050
121	Cyanide*	0.015	0.006
122	Lead	0.021	0.010
124	Nickel	0.096	0.063
125	Selenium	0.061	0.027
128	Zinc*	0.073	0.031
	Aluminum*	0.321	0.159
	Oil & Grease	0.996	0.598
	Total Suspended Solids	2.042	0.971
	pH	Within the range of 7.0 to 10.0 at all times.	

Continuous Rod Casting - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118	Cadmium	0.066	0.029
119	Chromium*	0.086	0.035
120	Copper	0.368	0.194
121	Cyanide*	0.056	0.024
122	Lead	0.082	0.039
124	Nickel	0.372	0.246
125	Selenium	0.239	0.107
128	Zinc*	0.283	0.118
	Aluminum*	1.247	0.621
	Oil & Grease	3.878	2.327
	Total Suspended Solids	7.950	3.781
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-36 (Continued)

BAT MASS LIMITATIONS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Continuous Rod Casting - Spent Lubricant

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.0007	0.0003
119 Chromium*	0.00086	0.0004
120 Copper	0.0037	0.0020
121 Cyanide*	0.0006	0.0002
122 Lead	0.0008	0.0004
124 Nickel	0.0038	0.0025
125 Selenium	0.0024	0.0011
128 Zinc*	0.0029	0.0012
Aluminum*	0.0127	0.0063
Oil & Grease	0.0393	0.0236
Total Suspended Solids	0.0805	0.0383
pH	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched		
118 Cadmium	0.693	0.306
119 Chromium*	0.896	0.367
120 Copper	3.870	2.037
121 Cyanide*	0.591	0.245
122 Lead	0.856	0.408
124 Nickel	3.911	2.587
125 Selenium	2.506	1.120
128 Zinc*	2.974	1.243
Aluminum*	13.098	6.519
Oil & Grease	40.740	24.444
Total Suspended Solids	83.517	39.722
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-36 (Continued)

BAT MASS LIMITATIONS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.262	0.109
	Aluminum*	1.151	0.573
	Oil & Grease	3.580	2.148
	Total Suspended Solids	7.339	3.491
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.473	0.209
119	Chromium*	0.612	0.251
120	Copper	2.643	1.391
121	Cyanide*	0.404	0.167
122	Lead	0.584	0.278
124	Nickel	2.671	1.767
125	Selenium	1.711	0.765
128	Zinc*	2.031	0.849
	Aluminum*	8.944	4.451
	Oil & Grease	27.820	16.692
	Total Suspended Solids	57.031	27.125
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-36 (Continued)

BAT MASS LIMITATIONS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.657	0.290
119	Chromium*	0.851	0.348
120	Copper	3.673	1.933
121	Cyanide*	0.561	0.232
122	Lead	0.812	0.387
124	Nickel	3.711	2.455
125	Selenium	2.378	1.063
128	Zinc*	2.822	1.179
	Aluminum*	12.429	6.186
	Oil & Grease	38.660	23.196
	Total Suspended Solids	79.253	37.694
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-37

PRODUCTION OPERATIONS - DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Operation	Waste Stream	Normalized BAT Discharge l/kkg	Normalized BAT Discharge (gpt)	Production Normalizing Parameter
Core				
Drawing with emulsions or soaps	Spent lubricants	416.5	(99.89)	Mass of aluminum drawn with emulsions or soaps
Annealing	None	0	(0)	
Stationary casting	None	0	(0)	
Homogenizing	None	0	(0)	
Artificial aging	None	0	(0)	
Degreasing	Spent solvent	0	(0)	
Sawing	Spent lubricant	4.807	(1.153)	Mass of aluminum drawn with emulsions or soaps
Swaging	None	0	(0)	
Miscellaneous nondescript wastewater sources	Various	45	(10.80)	Mass of aluminum drawn with emulsions or soaps
	Total Core	466.3	(111.9)	
Ancillary				
Continuous rod casting	Contact cooling water	193.9	(46.54)	Mass of rod cast by continuous methods
	Spent lubricant	1.964	(0.471)	Mass of rod cast by continuous methods
Solution heat treatment	Contact cooling water	2,037	(488.5)	Mass of aluminum quenched
Cleaning or etching	Bath	179	(42.96)	Mass of aluminum cleaned or etched
	Rinse	1,397	(333.8)	Mass of aluminum cleaned or etched
	Scrubber liquor	1,933	(463.5)	Mass of aluminum cleaned or etched

Table X-38

BAT MASS LIMITATIONS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Drawing With Emulsions or Soaps - Core Waste Streams

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum drawn with emulsions or soaps			
118	Cadmium	0.159	0.070
119	Chromium*	0.205	0.084
120	Copper	0.886	0.466
121	Cyanide*	0.135	0.056
122	Lead	0.196	0.094
124	Nickel	0.895	0.592
125	Selenium	0.574	0.256
128	Zinc*	0.681	0.285
	Aluminum*	2.998	1.492
	Oil & Grease	9.326	5.596
	Total Suspended Solids	19.118	9.093
	pH	Within the range of 7.0 to 10.0 at all times.	

Continuous Rod Casting - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods			
118	Cadmium	0.066	0.029
119	Chromium*	0.086	0.035
120	Copper	0.368	0.194
121	Cyanide*	0.056	0.024
122	Lead	0.082	0.039
124	Nickel	0.372	0.246
125	Selenium	0.239	0.107
128	Zinc*	0.283	0.118
	Aluminum*	1.247	0.620
	Oil & Grease	3.878	2.327
	Total Suspended Solids	7.950	3.781
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-38 (Continued)

BAT MASS LIMITATIONS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Continuous Rod Casting - Spent Lubricant

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.0007	0.0003
119 Chromium*	0.0009	0.0004
120 Copper	0.0037	0.0020
121 Cyanide*	0.0006	0.0003
122 Lead	0.0008	0.0004
124 Nickel	0.0038	0.0004
125 Selenium	0.0024	0.0025
128 Zinc*	0.0029	0.0011
Aluminum*	0.0126	0.0012
Oil & Grease	0.0393	0.0063
Total Suspended Solids	0.0805	0.0236
		0.0383
pH	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched		
118 Cadmium	0.693	0.306
119 Chromium*	0.897	0.367
120 Copper	3.870	2.037
121 Cyanide*	0.591	0.244
122 Lead	0.856	0.408
124 Nickel	3.911	2.587
125 Selenium	2.506	1.120
128 Zinc*	2.974	1.243
Aluminum*	13.098	6.518
Oil & Grease	40.740	24.444
Total Suspended Solids	83.517	39.722
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-38 (Continued)

BAT MASS LIMITATIONS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Cleaning or Etching - Bath

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.262	0.109
	Aluminum*	1.151	0.573
	Oil & Grease	3.580	2.148
	Total Suspended Solids	7.339	3.491
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.473	0.209
119	Chromium*	0.612	0.251
120	Copper	2.643	1.391
121	Cyanide*	0.404	0.167
122	Lead	0.584	0.278
124	Nickel	2.671	1.767
125	Selenium	1.711	0.765
128	Zinc*	2.031	0.849
	Aluminum*	8.944	4.451
	Oil & Grease	27.820	16.692
	Total Suspended Solids	57.031	27.125
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table X-38 (Continued)

BAT MASS LIMITATIONS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched		
118 Cadmium	0.657	0.290
119 Chromium*	0.851	0.348
120 Copper	3.673	1.933
121 Cyanide*	0.561	0.232
122 Lead	0.812	0.387
124 Nickel	3.711	2.455
125 Selenium	2.378	1.063
128 Zinc*	2.822	1.179
Aluminum*	12.429	6.186
Oil & Grease	38.660	23.196
Total Suspended Solids	79.253	37.694
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

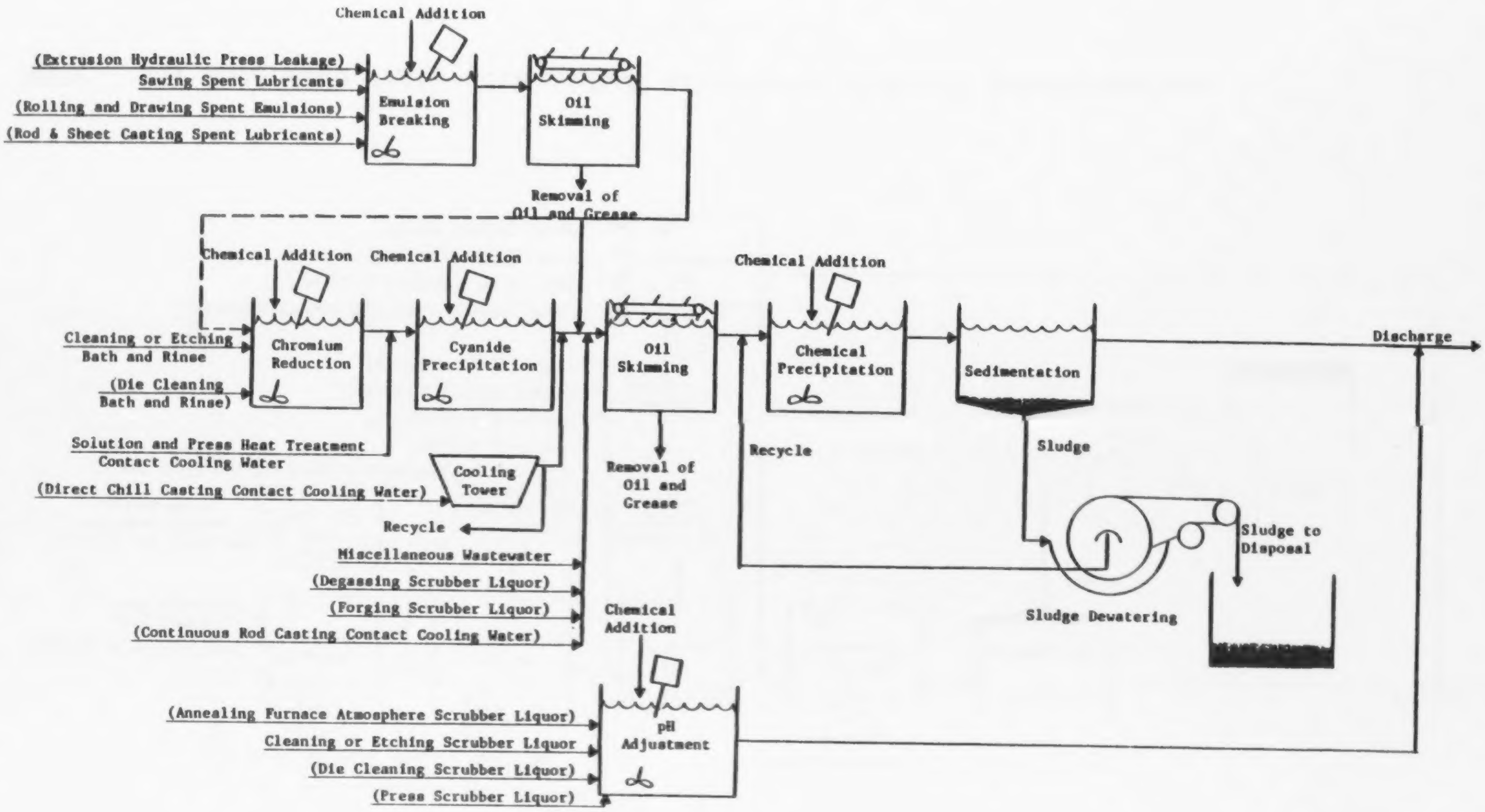
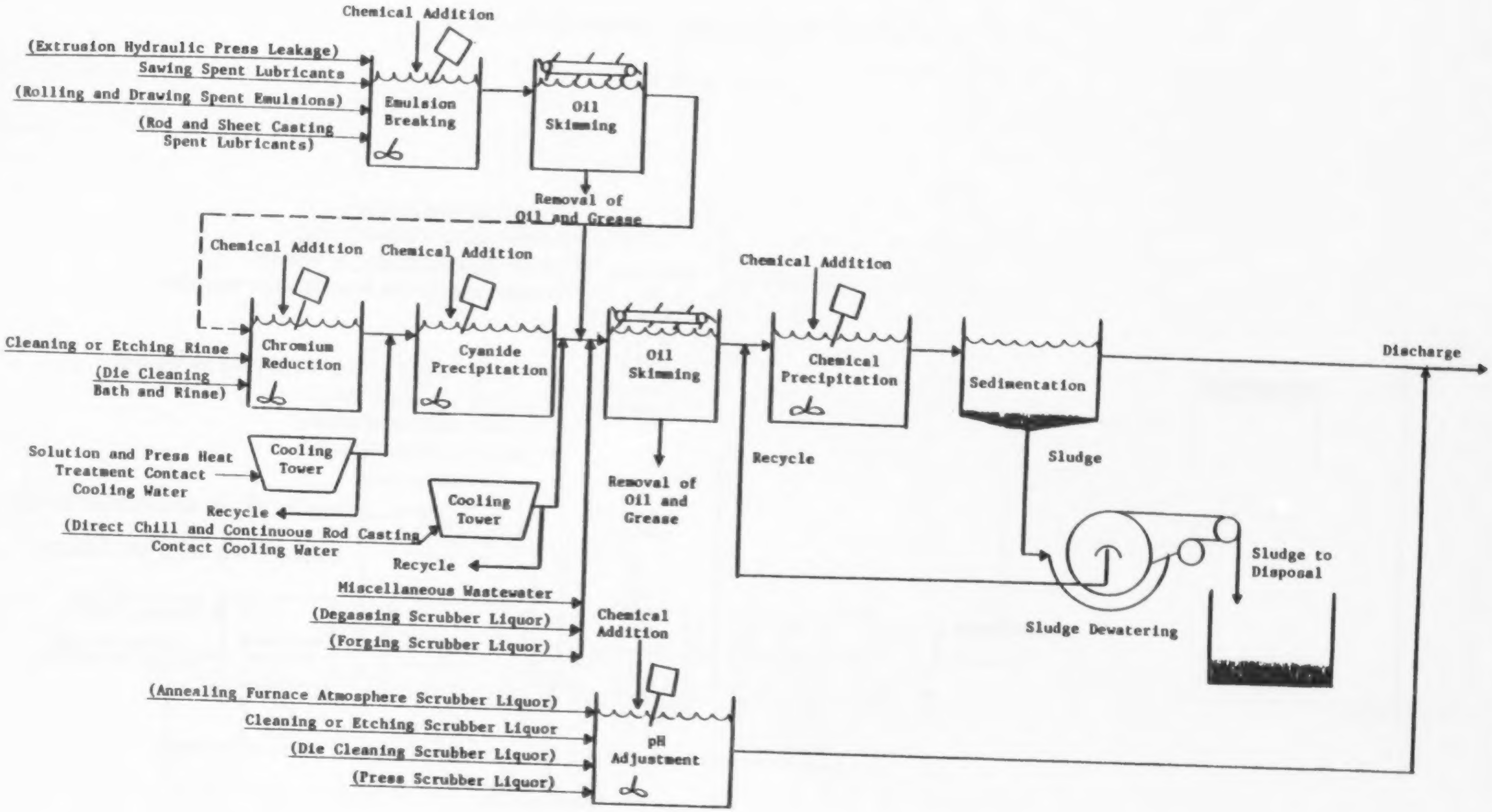

Chemical Addition
(Extrusion Hydraulic Press Leakage)
Sawing Spent Lubricants
(Rolling and Drawing Spent Emulsions)
(Rod & Sheet Casting Spent Lubricants)
Emulsion Breaking
Oil Skimming
Removal of Oil and Grease
Chemical Addition
Chemical Addition
Cleaning or Etching Bath and Rinse
(Die Cleaning Bath and Rinse)
Chromium Reduction
Cyanide Precipitation
Solution and Press Heat Treatment Contact Cooling Water
(Direct Chill Casting Contact Cooling Water)
Cooling Tower
Recycle
Miscellaneous Wastewater
(Degassing Scrubber Liquor)
(Forging Scrubber Liquor)
(Continuous Rod Casting Contact Cooling Water)
Oil Skimming
Removal of Oil and Grease
Chemical Addition
Chemical Precipitation
Recycle
Sedimentation
Sludge
Sludge Dewatering
Sludge to Disposal
Discharge
Chemical Addition
(Annealing Furnace Atmosphere Scrubber Liquor)
Cleaning or Etching Scrubber Liquor
(Die Cleaning Scrubber Liquor)
(Press Scrubber Liquor)
pH Adjustment

Figure X-1

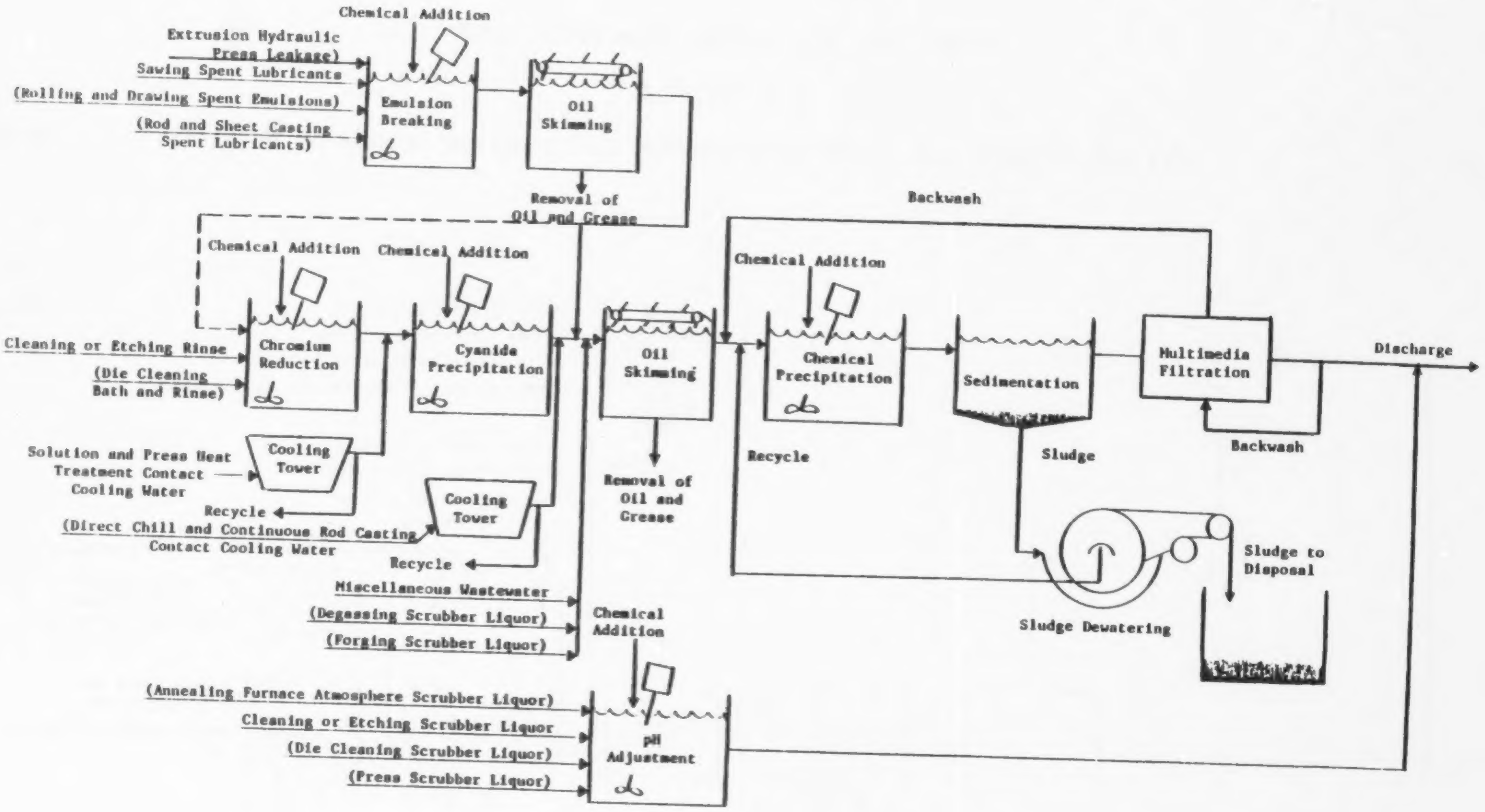
BAT TREATMENT TRAIN FOR OPTION 1


Chemical Addition
(Extrusion Hydraulic Press Leakage)
Sawing Spent Lubricants
(Rolling and Drawing Spent Emulsions)
(Rod and Sheet Casting Spent Lubricants)
Emulsion Breaking
Oil Skimming
Removal of Oil and Grease
Chemical Addition
Chemical Addition
Cleaning or Etching Rinse
(Die Cleaning Bath and Rinse)
Chromium Reduction
Cyanide Precipitation
Solution and Press Heat Treatment Contact Cooling Water
Cooling Tower
Recycle
(Direct Chill and Continuous Rod Casting Contact Cooling Water
Cooling Tower
Recycle
Miscellaneous Wastewater
(Degassing Scrubber Liquor)
(Forging Scrubber Liquor)
Oil Skimming
Removal of Oil and Grease
Chemical Addition
Chemical Precipitation
Recycle
Sedimentation
Sludge
Sludge Dewatering
Sludge to Disposal
Discharge
Chemical Addition
(Annealing Furnace Atmosphere Scrubber Liquor)
Cleaning or Etching Scrubber Liquor
(Die Cleaning Scrubber Liquor)
(Press Scrubber Liquor)
pH Adjustment

NOTE: ( ) indicates waste streams not associated with all subcategories.

Figure X-2

BAT TREATMENT TRAIN FOR OPTION 2


Chemical Addition
Extrusion Hydraulic Press Leakage)
Sawing Spent Lubricants
(Rolling and Drawing Spent Emulsions)
(Rod and Sheet Casting Spent Lubricants)
Emulsion Breaking
Oil Skimming
Removal of Oil and Grease
Chemical Addition
Chemical Addition
Cleaning or Etching Rinse
(Die Cleaning Bath and Rinse)
Chromium Reduction
Cyanide Precipitation
Solution and Press Heat Treatment Contact Cooling Water
Cooling Tower
Recycle
(Direct Chill and Continuous Rod Casting Contact Cooling Water
Cooling Tower
Recycle
Miscellaneous Wastewater
(Degassing Scrubber Liquor)
(Forging Scrubber Liquor)
Oil Skimming
Removal of Oil and Grease
Chemical Addition
(Annealing Furnace Atmosphere Scrubber Liquor)
Cleaning or Etching Scrubber Liquor
(Die Cleaning Scrubber Liquor)
(Press Scrubber Liquor)
pH Adjustment
Backwash
Chemical Addition
Chemical Precipitation
Recycle
Sedimentation
Sludge
Multimedia Filtration
Backwash
Discharge
Sludge to Disposal
Sludge Dewatering

NOTE: ( ) indicates waste streams not associated with all subcategories.

Figure X-3

BAT TREATMENT TRAIN FOR OPTION 3

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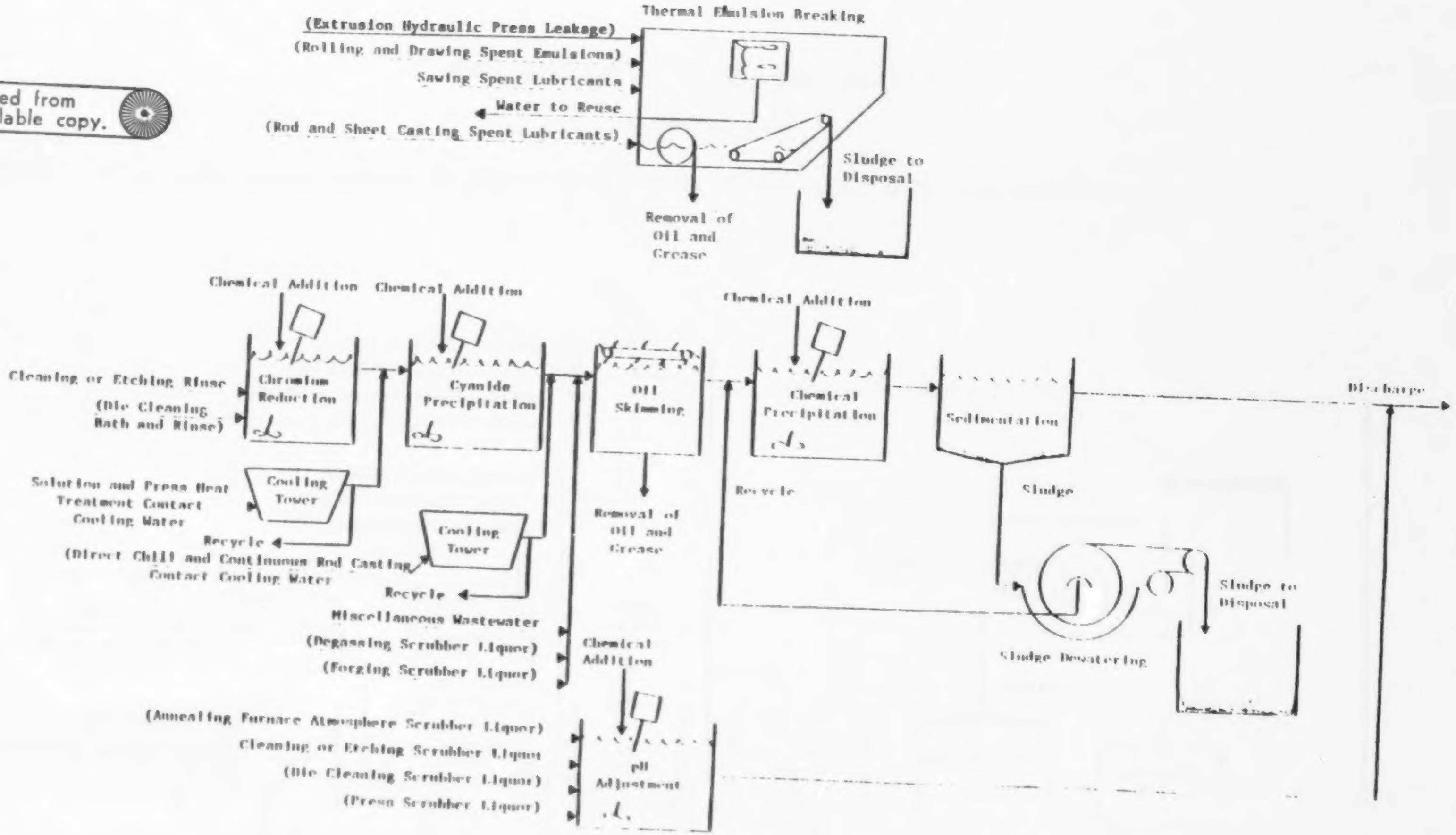
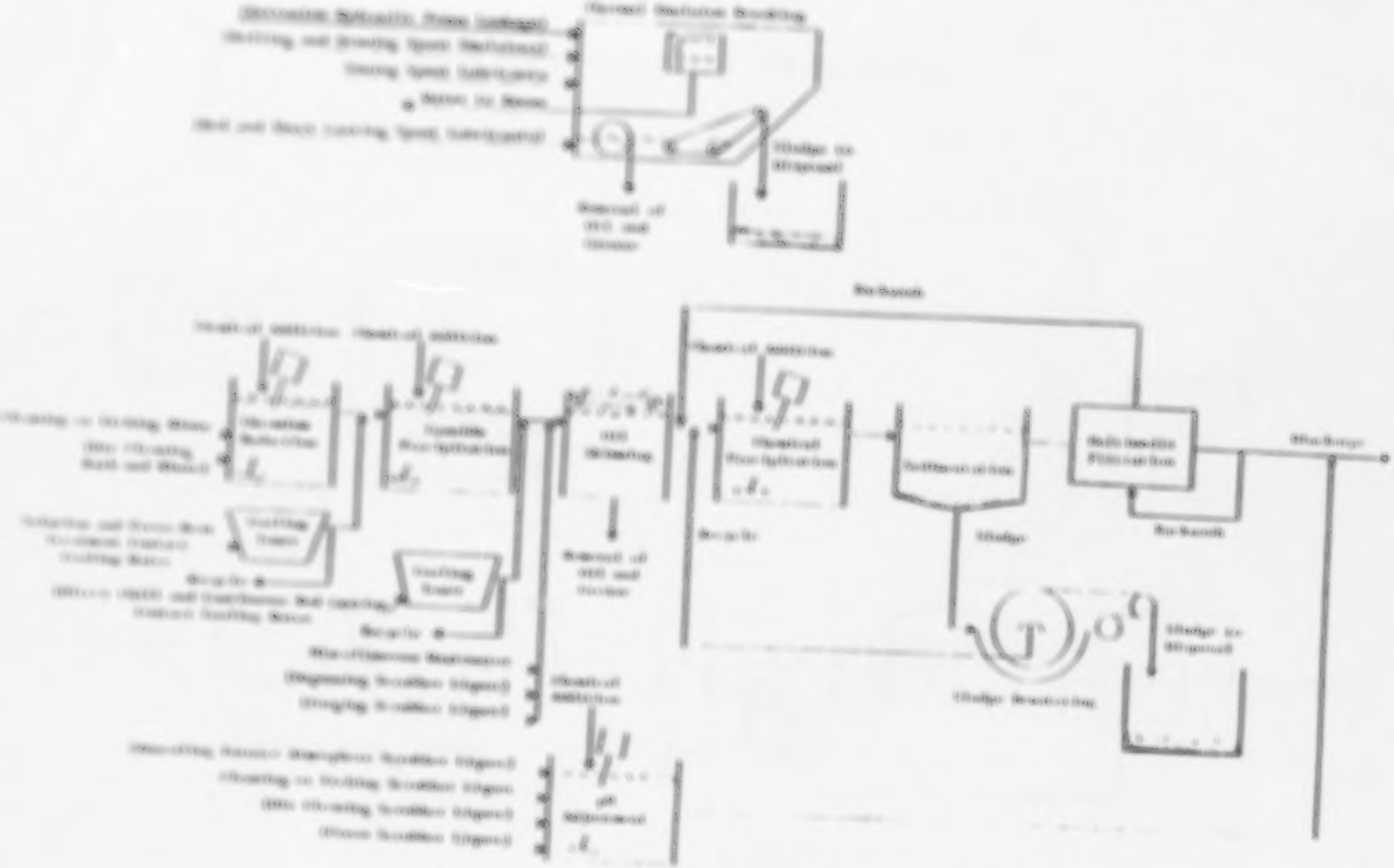

Thermal Emulsion Breaking
(Extrusion Hydraulic Press Leakage)
(Rolling and Drawing Spent Emulsions)
Sawing Spent Lubricants
Water to Reuse
(Rod and Sheet Casting Spent Lubricants)
Sludge to Disposal
Removal of Oil and Grease
Chemical Addition
Chemical Addition
Chemical Addition
Cleaning or Etching Rinse
(Die Cleaning Bath and Rinse)
Chromium Reduction
Cyanide Precipitation
Oil Skimming
Chemical Precipitation
Sedimentation
Discharge
Solution and Press Heat Treatment Contact Cooling Water
Cooling Tower
Recycle
(Direct Chill and Continuous Rod Casting Contact Cooling Water
Cooling Tower
Recycle
Removal of Oil and Grease
Recycle
Sludge
Miscellaneous Wastewater
(Degassing Scrubber Liquor)
(Forging Scrubber Liquor)
Chemical Addition
Sludge Dewatering
Sludge to Disposal
(Annealing Furnace Atmosphere Scrubber Liquor)
Cleaning or Etching Scrubber Liquor
(Die Cleaning Scrubber Liquor)
(Press Scrubber Liquor)
pH Adjustment

NOTE: ( ) indicates waste streams not associated with all subcategories.

Figure X-4

BAT TREATMENT TRAIN FOR OPTION 4



Reproduced from best available copy.

NOTE: ( ) indicates waste streams not associated with all subcategories.

Figure X-5

BAT TREATMENT TRAIN FOR OPTION 5

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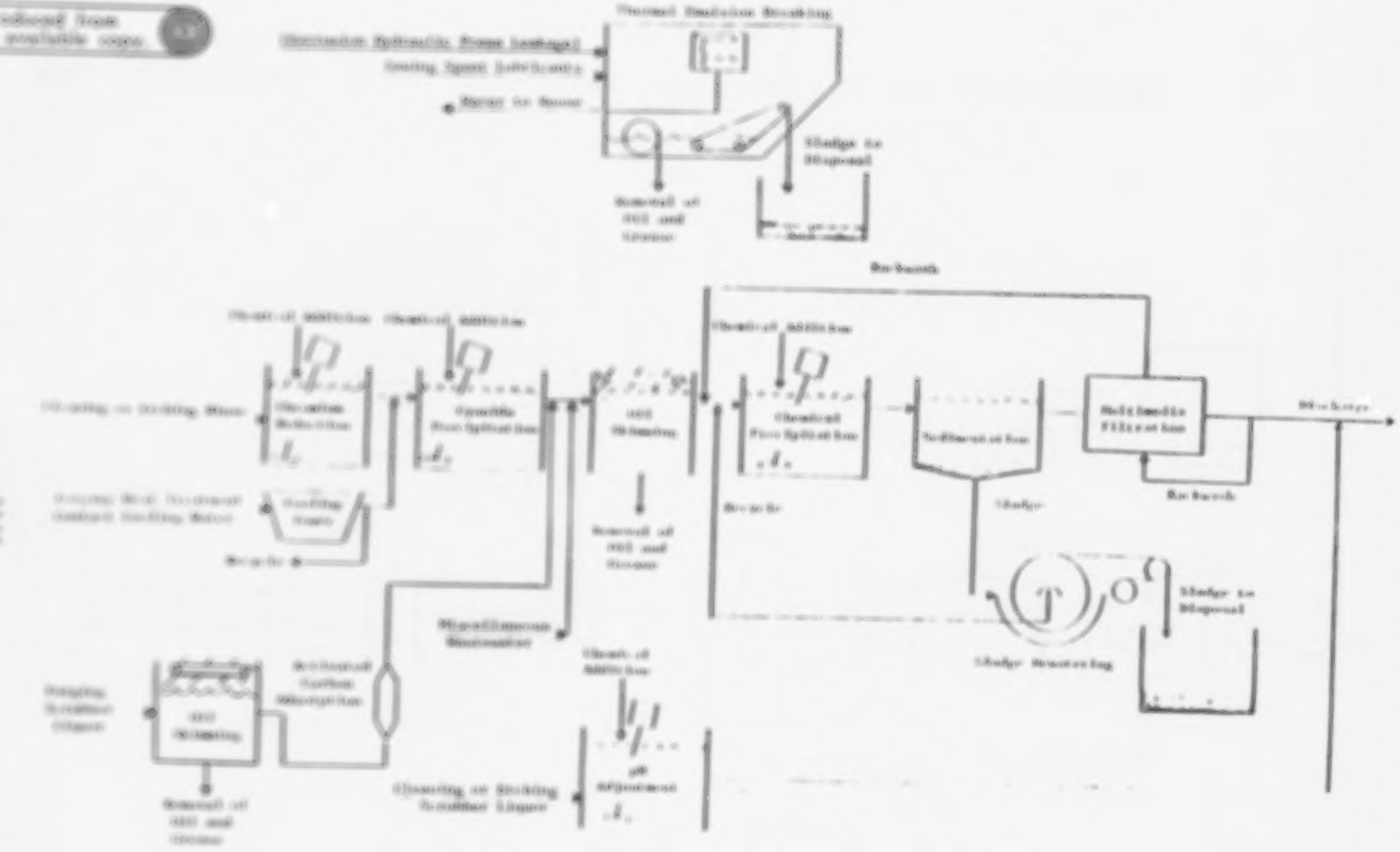

Figure X-6

BAT TREATMENT TRAIN FOR OPTION 6

SECTION XI

NEW SOURCE PERFORMANCE STANDARDS

The basis for new source performance standards (NSPS) under Section 306 of the Clean Water Act is the best available demonstrated technology (BDT). New plants have the opportunity to design the best and most efficient production processes and wastewater treatment technologies. Therefore, NSPS includes process changes, in-plant controls (including elimination of wastewater streams), operating procedure changes, and end-of-pipe treatment technologies to reduce pollution to the maximum extent possible. This section describes the control technology for treatment of wastewater from new sources and presents mass discharge limitations of regulated pollutants for NSPS, based on the described control technology.

TECHNICAL APPROACH TO NSPS

Most wastewater reduction and process changes applicable to a new source have been considered previously for the BAT options. For this reason, five options were considered as the basis for NSPS, all identical to BAT options in Section X. Due to high costs and low environmental benefits, BAT Option 6 was not considered for NSPS. The five options are summarized below and presented in greater detail in Section X.

In summary form, the treatment technologies considered for new aluminum forming facilities are:

NSPS Option 1 is based on:

Oil skimming,

Lime and settle (chemical precipitation of metals), followed by sedimentation), and

pH adjustment; and, where required,

Cyanide removal,

Hexavalent chromium reduction, and

Chemical emulsion breaking.

NSPS Option 2 is based on:

NSPS Option 1, plus process wastewater flow minimization by the following methods:

- Heat treatment contact cooling water recycle through cooling towers.
- Continuous rod casting contact cooling water recycle.
- Air pollution control scrubber liquor recycle.
- Extrusion press leakage recycle.
- Countercurrent cascade rinsing or other water efficient methods applied to cleaning or etching and extrusion die cleaning rinses.
- Alternative fluxing or in-line refining methods, neither of which require wet air pollution control, for degassing aluminum melts.

NSPS Option 3 is based on:

NSPS Option 2, plus multimedia filtration at the end of the NSPS Option 2 treatment train.

NSPS Option 4 is based on:

NSPS Option 2 plus thermal emulsion breaking or contractor hauling for concentrated emulsions.

NSPS Option 5 is based on:

NSPS Option 4, plus multimedia filtration at the end of the NSPS Option 4 treatment train.

A more detailed discussion of these options and their applicability with each of the six subcategories is presented in Section X.

NSPS OPTION SELECTION

EPA is promulgating the best available demonstrated technology for all six subcategories in the aluminum forming category equivalent to BAT technology with the addition of filtration prior to discharge (NSPS Option 3). As discussed in Sections IX and X, these technologies are currently used at plants within this point source category. Filtration has been included in the NSPS model technology because new plants have the opportunity to design the most efficient process water use and wastewater reduction techniques within their processes, thereby reducing the size of and cost of filtration equipment. Specifically, the design of new plants can be based on recycle of contact cooling water through cooling towers, recycle of air pollution control scrubber liquor or the use of dry air pollution control equipment, recirculation of extrusion press hydraulic fluid leakage, and use of countercurrent cascade rinsing. New plants also have the opportunity to consider alternate fluxing or in-line refining methods during the preliminary design of the facility.

The NSPS regulatory flows are the same as the BAT regulatory flows discussed in Section X with the exception of extrusion press hydraulic fluid leakage. The NSPS flow for extrusion press hydraulic fluid leakage is based on data from two plants which currently recycle this flow. The Agency concluded that recycle was not appropriate for existing sources because of the extensive retrofit which would be involved. However, a new plant has the opportunity to build into the plant when it is being constructed the necessary troughs and diking required to recycle this stream.

In order to evaluate new sources a normal plant was developed for each subcategory. The characteristics of a normal plant are shown on Tables VIII-12 through VIII-17 (pp. 399-410). Costs developed for each new source option considered were developed and are shown on Table VIII-18 (p. 412). Pollutant reduction benefits are shown in Section X (Tables X-14 through X-19, pp 1099-1104). new sources regardless of whether they are plants with major modifications or greenfield sites, will have costs that are not greater than the costs that existing sources would incur in achieving equivalent pollutant discharge reduction. Based on this the Agency believes that the selected NSPS (NSPS Option 3) is appropriate for both greenfield sites and existing sites undergoing major modifications (e.g., a primary aluminum plant which installs a rolling operation).

Costs and Environmental Benefits of Treatment Options

Costs for an individual new source can be estimated using the methods described in Section VIII. The Agency has not estimated total costs for the category or subcategories since it is not known how many new aluminum forming plants will be built. Estimates of treatment performance for an individual "normal plant" in each subcategory are presented in Tables X-14 through X-19 (pp. 1099 through 1104).

REGULATED POLLUTANT PARAMETERS

The Agency has no reason to believe that the pollutants that will be found in significant quantities in processes within new sources will be any different than with existing sources. Consequently, pollutants selected for regulation, in accordance with the rationale of Section VI, are the same ones for each subcategory that were selected for BAT plus TSS, oil and grease, and pH. At NSPS, as at BAT, the other toxic metals, cadmium, copper, lead, nickel, and selenium, and the "toxic" organic pollutants will be controlled by regulation of chromium, zinc, aluminum, and oil and grease.

NEW SOURCE PERFORMANCE STANDARDS

The regulatory production normalized flows for NSPS (NSPS Option 3) are the same as the production normalized flows for the selected BAT option (Option 2) with the exception of the extrusion press hydraulic fluid leakage stream. As discussed in Section X, EPA considered and ultimately rejected recycle of hydraulic fluid leakage from extrusion presses for existing plants. After studying two press leakage recycle systems in the category, we concluded that new plants can design and install collection and routing systems for hydraulic fluid leakage during original plant construction. As such, new plants would not incur the costs of retrofitting a collection system. One of the two plants currently recycling the hydraulic fluid leakage has reported that on a portion of the leakage that it recycles through oil separation and filter, it has observed a decrease in maintenance on the extrusion system because of the removal of tramp oils, dirt, and debris. The NSPS flow allowance for extrusion press hydraulic fluid leakage is 298 l/kkg (71.5 gal/ton). This flow is based on the average of flows from the two plants in which the extrusion presses have been designed and built to allow the recirculation of the hydraulic fluid leakage.

NSPS Option 3 is based on the treatment effectiveness values for lime, settle, and filter technology, as presented in Table VII-20 (p. 807). The mass of pollutant allowed to be discharged per mass of product is calculated by multiplying the appropriate treatment effectiveness value (one day maximum and ten day average values) (mg/l) by the production normalized flows (l/kkg). When these calculations are performed, the mass-based NSPS can be derived for the selected option (NSPS Option 3). These values are presented for each of the six subcategories in Tables XI-1 through XI-6.

Table XI-1

NSPS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Rolling With Neat Oils - Core Waste Streams Without An Annealing Furnace Scrubber

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum rolled with neat oils		
118	Cadmium	0.011	0.004
119	Chromium*	0.021	0.0083
120	Copper	0.071	0.034
121	Cyanide*	0.011	0.0044
122	Lead	0.016	0.007
124	Nickel	0.030	0.021
125	Selenium	0.045	0.021
128	Zinc*	0.057	0.021
	Aluminum*	0.338	0.023
	Oil & Grease*	0.53	0.150
	Total Suspended Solids*	0.830	0.53
			0.664
	pH*	Within the range of 7.0 to 10.0 at all times.	

Rolling With Neat Oils - Core Waste Streams With An Annealing Furnace Scrubber

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum rolled with neat oils		
118	Cadmium	0.016	0.007
119	Chromium*	0.030	0.0123
120	Copper	0.105	0.050
121	Cyanide*	0.016	0.0065
122	Lead	0.023	0.011
124	Nickel	0.045	0.030
125	Selenium	0.070	0.030
128	Zinc*	0.084	0.030
	Aluminum*	0.499	0.0343
	Oil & Grease*	0.817	0.221
	Total Suspended Solids*	1.225	0.817
			0.980
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-1 (Continued)

NSPS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Continuous Sheet Casting - Spent Lubricant

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118	Cadmium	0.00039	0.00016
119	Chromium*	0.00073	0.00029
120	Copper	0.0025	0.0012
121	Cyanide*	0.00039	0.00016
122	Lead	0.0006	0.00026
124	Nickel	0.0011	0.00073
125	Selenium	0.0016	0.00073
128	Zinc*	0.0020	0.00082
	Aluminum*	0.012	0.0053
	Oil & Grease*	0.0197	0.019
	Total Suspended Solids*	0.0295	0.022
	pH*	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	0.407	0.163
119	Chromium*	0.76	0.31
120	Copper	2.607	1.243
121	Cyanide*	0.41	0.17
122	Lead	0.571	0.265
124	Nickel	1.120	0.754
125	Selenium	1.670	0.754
128	Zinc*	2.08	0.86
	Aluminum*	12.446	5.520
	Oil & Grease*	20.37	20.37
	Total Suspended Solids*	30.555	24.444
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-1 (Continued)

NSPS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Bath

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.036	0.014
119	Chromium*	0.066	0.027
120	Copper	0.229	0.109
121	Cyanide*	0.036	0.015
122	Lead	0.050	0.023
124	Nickel	0.099	0.066
125	Selenium	0.147	0.066
128	Zinc*	0.183	0.075
	Aluminum*	1.094	0.485
	Oil & Grease*	1.79	1.79
	Total Suspended Solids*	2.685	2.148
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.278	0.111
119	Chromium*	0.52	0.21
120	Copper	1.781	0.849
121	Cyanide*	0.28	0.11
122	Lead	0.390	0.181
124	Nickel	0.765	0.515
125	Selenium	1.140	0.515
128	Zinc*	1.42	0.59
	Aluminum*	8.499	3.70
	Oil & Grease*	13.91	13.91
	Total Suspended Solids*	20.865	16.69
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-1 (Continued)

NSPS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched		
118 Cadmium	0.387	0.154
119 Chromium*	0.715	0.29
120 Copper	2.474	1.179
121 Cyanide*	0.387	0.16
122 Lead	0.541	0.251
124 Nickel	1.063	0.715
125 Selenium	1.585	0.715
128 Zinc*	1.97	0.81
Aluminum*	11.81	5.238
Oil & Grease*	19.33	19.33
Total Suspended Solids*	28.995	23.196
pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-2

NSPS FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Rolling With Emulsions - Core Waste Streams

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum rolled with emulsions		
118	Cadmium	0. 26	0.010
119	Chromium*	0. 48	0.020
120	Copper	0. 66	0.079
121	Cyanide*	0. 26	0.011
122	Lead	0. 37	0.017
124	Nickel	0. 71	0.048
125	Selenium	0. 06	0.048
128	Zinc*	0. 33	0.055
	Aluminum*	0. 93	0.352
	Oil & Grease*	1. 0	1.30
	Total Suspended Solids*	1. 47	1.558
	pH*	Within the range of 7.0 to 10.0 at all times.	

Direct Chill Castig - Contact Cooling Water

	Pollutant or Pollutant Property	Maximu for Any On Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of alumnum cast by direct chill methods		
118	Cadmium	0.26	0.106
119	Chromium*	0.4	0.20
120	Copper	1.71	0.811
121	Cyanide*	0.2	0.11
122	Lead	0.32	0.173
124	Nickel	0.71	0.492
125	Selenium	1.00	0.492
128	Zinc*	1.3	0.59
	Aluminum*	8.13	3.602
	Oil & Grease*	13.2	13.29
	Total Suspended Solids*	19.91	15.948
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-2 (Continued)

NSPS FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Solution Heat Treatment - Contact Cooling Water

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	0.407	0.163
119	Chromium*	0.76	0.31
120	Copper	2.607	1.243
121	Cyanide*	0.41	0.17
122	Lead	0.571	0.265
124	Nickel	1.120	0.754
125	Selenium	1.670	0.754
128	Zinc*	2.08	0.86
	Aluminum*	12.446	5.520
	Oil & Grease*	20.37	20.37
	Total Suspended Solids*	30.555	24.444
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.036	0.014
119	Chromium*	0.067	0.027
120	Copper	0.229	0.109
121	Cyanide*	0.036	0.015
122	Lead	0.050	0.023
124	Nickel	0.099	0.066
125	Selenium	0.147	0.066
128	Zinc*	0.183	0.075
	Aluminum*	1.094	0.485
	Oil & Grease*	1.79	1.79
	Total Suspended Solids*	2.685	2.148
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-2 (Continued)

NSPS FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Cleaning or Etching - Rinse

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.278	0.111
119	Chromium*	0.52	0.21
120	Copper	1.781	0.849
121	Cyanide*	0.28	0.11
122	Lead	0.390	0.181
124	Nickel	0.765	0.515
125	Selenium	1.140	0.515
128	Zinc*	1.42	0.59
	Aluminum*	8.499	3.770
	Oil & Grease*	13.91	13.91
	Total Suspended Solids*	20.87	16.70
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.387	0.154
119	Chromium*	0.72	0.29
120	Copper	2.474	1.179
121	Cyanide*	0.39	0.16
122	Lead	0.541	0.251
124	Nickel	1.063	0.715
125	Selenium	1.585	0.715
128	Zinc*	1.97	0.81
	Aluminum*	11.81	5.24
	Oil & Grease*	19.33	19.33
	Total Suspended Solids*	29.00	23.20
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-3

NSPS FOR THE EXTRUSION SUBCATEGORY

Extrusion - Core Waste Streams

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum extruded		
118	Cadmium	0.068	0.027
119	Chromium*	0.13	0.051
120	Copper	0.435	0.208
121	Cyanide*	0.068	0.027
122	Lead	0.095	0.044
124	Nickel	0.187	0.126
125	Selenium	0.279	0.126
128	Zinc*	0.35	0.14
	Aluminum*	2.07	0.92
	Oil & Grease*	3.39	3.39
	Total Suspended Solids*	5.102	4.07
	pH*	Within the range of 7.0 to 10.0 at all times.	

Direct Chill Casting - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cast by direct chill methods		
118	Cadmium	0.266	0.106
119	Chromium*	0.49	0.20
120	Copper	1.701	0.811
121	Cyanide*	0.27	0.11
122	Lead	0.372	0.173
124	Nickel	0.731	0.492
125	Selenium	1.080	0.492
128	Zinc*	1.36	0.56
	Aluminum*	8.12	3.60
	Oil & Grease*	13.29	13.29
	Total Suspended Solids*	19.935	15.95
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-3 (Continued)

NSPS FOR THE EXTRUSION SUBCATEGORY

Solution and Press Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	0.407	0.163
119	Chromium*	0.76	0.31
120	Copper	2.607	1.243
121	Cyanide*	0.41	0.17
122	Lead	0.571	0.265
124	Nickel	1.120	0.754
125	Selenium	1.670	0.754
128	Zinc*	2.08	0.86
	Aluminum*	12.45	5.52
	Oil & Grease*	20.37	20.37
	Total Suspended Solids*	30.56	24.45
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.036	0.014
119	Chromium*	0.067	0.027
120	Copper	0.229	0.109
121	Cyanide*	0.036	0.015
122	Lead	0.050	0.023
124	Nickel	0.099	0.066
125	Selenium	0.147	0.066
128	Zinc*	0.183	0.075
	Aluminum*	1.094	0.485
	Oil & Grease*	1.79	1.79
	Total Suspended Solids*	2.69	2.15
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-3 (Continued)

NSPS FOR THE EXTRUSION SUBCATEGORY

Cleaning or Etching - Rinse

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.278	0.111
119	Chromium*	0.52	0.21
120	Copper	1.781	0.849
121	Cyanide*	0.28	0.11
122	Lead	0.390	0.181
124	Nickel	0.765	0.515
125	Selenium	1.140	0.515
128	Zinc*	1.42	0.59
	Aluminum*	8.50	3.77
	Oil & Grease*	13.91	13.91
	Total Suspended Solids*	20.87	16.70
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.387	0.154
119	Chromium*	0.72	0.29
120	Copper	2.474	1.179
121	Cyanide*	0.39	0.16
122	Lead	0.541	0.251
124	Nickel	1.063	0.715
125	Selenium	1.585	0.715
128	Zinc*	1.97	0.81
	Aluminum*	11.81	5.24
	Oil & Grease*	19.33	19.33
	Total Suspended Solids*	29.00	23.20
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-3 (Continued)

NSPS FOR THE EXTRUSION SUBCATEGORY

Degassing - Scrubber Liquor

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
		mg/kg (lb/million lbs) of aluminum degassed	
118	Cadmium	0.00	0.00
119	Chromium*	0.00	0.00
120	Copper	0.00	0.00
121	Cyanide*	0.00	0.00
122	Lead	0.00	0.00
124	Nickel	0.00	0.00
125	Selenium	0.00	0.00
128	Zinc*	0.00	0.00
	Aluminum*	0.00	0.00
	Oil & Grease*	0.00	0.00
	Total Suspended Solids*	0.00	0.00
	pH*	Within the range of 7.0 to 10.0 at all times.	

Extrusion Press Hydraulic Fluid Leakage

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
		mg/kg (lb/million lbs) of aluminum extruded	
118	Cadmium	0.060	0.024
119	Chromium*	0.11	0.045
120	Copper	0.381	0.182
121	Cyanide*	0.060	0.024
122	Lead	0.084	0.039
124	Nickel	0.164	0.110
125	Selenium	0.244	0.110
128	Zinc*	0.31	0.126
	Aluminum*	1.82	0.81
	Oil & Grease*	2.98	2.98
	Total Suspended Solids*	4.47	3.58
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-4

NSPS FOR THE FORGING SUBCATEGORY

Forging - Core Waste Streams

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum forged		
118 Cadmium	0.010	0.004
119 Chromium*	0.019	0.008
120 Copper	0.064	0.030
121 Cyanide*	0.010	0.004
122 Lead	0.014	0.007
124 Nickel	0.027	0.018
125 Selenium	0.041	0.018
128 Zinc*	0.051	0.021
Aluminum*	0.305	0.135
Oil & Grease*	0.50	0.50
Total Suspended Solids*	0.75	0.60
pH*	Within the range of 7.0 to 10.0 at all times.	

Forging - Scrubber Liquor

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum forged		
118 Cadmium	0.019	0.008
119 Chromium*	0.035	0.014
120 Copper	0.121	0.058
121 Cyanide*	0.019	0.008
122 Lead	0.027	0.013
124 Nickel	0.052	0.035
125 Selenium	0.077	0.035
128 Zinc*	0.096	0.040
Aluminum*	0.576	0.256
Oil & Grease*	0.943	0.95
Total Suspended Solids*	1.42	1.13
pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-4 (Continued)

NSPS FOR THE FORGING SUBCATEGORY

Solution Heat Treatment - Contact Cooling Water

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	0.407	0.163
119	Chromium*	0.76	0.31
120	Copper	2.607	1.243
121	Cyanide*	0.41	0.163
122	Lead	0.571	0.265
124	Nickel	1.120	0.754
125	Selenium	1.670	0.754
128	Zinc*	2.08	0.86
	Aluminum*	12.45	5.52
	Oil & Grease*	20.37	20.37
	Total Suspended Solids*	30.56	24.45
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.036	0.014
119	Chromium*	0.066	0.027
120	Copper	0.229	0.109
121	Cyanide*	0.036	0.015
122	Lead	0.050	0.023
124	Nickel	0.099	0.066
125	Selenium	0.147	0.066
128	Zinc*	0.183	0.075
	Aluminum*	1.094	0.485
	Oil & Grease*	1.79	1.79
	Total Suspended Solids*	2.69	2.15
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-4 (Continued)

NSPS FOR THE FORGING SUBCATEGORY

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.278	0.111
119	Chromium*	0.52	0.21
120	Copper	1.781	0.849
121	Cyanide*	0.28	0.11
122	Lead	0.390	0.181
124	Nickel	0.765	0.515
125	Selenium	1.140	0.515
128	Zinc*	1.42	0.59
	Aluminum*	8.45	3.77
	Oil & Grease*	13.91	13.91
	Total Suspended Solids*	20.87	16.69
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.387	0.154
119	Chromium*	0.72	0.29
120	Copper	2.474	1.179
121	Cyanide*	0.39	0.155
122	Lead	0.541	0.251
124	Nickel	1.063	0.715
125	Selenium	1.585	0.715
128	Zinc*	1.97	0.812
	Aluminum*	11.81	5.24
	Oil & Grease*	19.33	19.33
	Total Suspended Solids*	29.00	23.20
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-5

NSPS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Drawing With Neat Oils - Core Waste Streams

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum drawn with neat oils		
118	Cadmium	0.010	0.004
119	Chromium*	0.019	0.008
120	Copper	0.064	0.030
121	Cyanide*	0.010	0.004
122	Lead	0.014	0.007
124	Nickel	0.027	0.018
125	Selenium	0.041	0.018
128	Zinc*	0.051	0.018
	Aluminum*	0.304	0.021
	Oil & Grease*	0.498	0.135
	Total Suspended Solids*	0.747	0.498
	pH*	Within the range of 7.0 to 10.0 at all times.	0.598

Continuous Rod Casting - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118	Cadmium	0.039	0.016
119	Chromium*	0.072	0.029
120	Copper	0.248	0.118
121	Cyanide*	0.039	0.016
122	Lead	0.054	0.025
124	Nickel	0.107	0.072
125	Selenium	0.159	0.072
128	Zinc*	0.198	0.082
	Aluminum*	1.185	0.526
	Oil & Grease*	1.939	1.939
	Total Suspended Solids*	2.909	2.327
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-5 (Continued)

NSPS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Continuous Rod Casting - Spent Lubricant

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods			
118	Cadmium	0.00039	0.00016
119	Chromium*	0.0008	0.0003
120	Copper	0.0025	0.0012
121	Cyanide*	0.0004	0.0002
122	Lead	0.00055	0.00026
124	Nickel	0.0011	0.00073
125	Selenium	0.0016	0.00073
128	Zinc*	0.0020	0.0008
	Aluminum*	0.012	0.0053
	Oil & Grease*	0.020	0.020
	Total Suspended Solids*	0.029	0.024
	pH*	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched			
118	Cadmium	0.407	0.163
119	Chromium*	0.754	0.306
120	Copper	2.607	1.243
121	Cyanide*	0.406	0.163
122	Lead	0.571	0.265
124	Nickel	1.120	0.754
125	Selenium	1.670	0.754
128	Zinc*	2.08	0.856
	Aluminum*	12.45	5.52
	Oil & Grease*	20.37	20.37
	Total Suspended Solids*	30.56	24.45
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-5 (Continued)

NSPS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.036	0.014
119	Chromium*	0.066	0.027
120	Copper	0.229	0.109
121	Cyanide*	0.036	0.015
122	Lead	0.050	0.023
124	Nickel	0.099	0.066
125	Selenium	0.147	0.066
128	Zinc*	0.183	0.075
	Aluminum*	1.094	0.485
	Oil & Grease*	1.79	1.79
	Total Suspended Solids*	2.69	2.15
	pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.278	0.111
119	Chromium*	0.515	0.209
120	Copper	1.781	0.849
121	Cyanide*	0.278	0.111
122	Lead	0.390	0.181
124	Nickel	0.765	0.515
125	Selenium	1.140	0.515
128	Zinc*	1.42	0.584
	Aluminum*	8.50	3.77
	Oil & Grease*	13.91	13.91
	Total Suspended Solids*	20.87	16.70
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-5 (Continued)

NSPS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.387	0.154
119	Chromium*	0.715	0.290
120	Copper	2.474	1.179
121	Cyanide*	0.387	0.155
122	Lead	0.541	0.251
124	Nickel	1.063	0.715
125	Selenium	1.585	0.715
128	Zinc*	1.97	0.812
	Aluminum*	11.81	5.24
	Oil & Grease*	19.33	19.33
	Total Suspended Solids*	29.00	23.20
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-6

NSPS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Drawing With Emulsions or Soaps - Core Waste Streams

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum drawn with emulsions or soaps		
118 Cadmium	0.093	0.037
119 Chromium*	0.173	0.070
120 Copper	0.597	0.284
121 Cyanide*	0.094	0.038
122 Lead	0.131	0.061
124 Nickel	0.257	0.173
125 Selenium	0.382	0.173
128 Zinc*	0.476	0.196
Aluminum*	2.85	1.27
Oil & Grease*	4.67	4.67
Total Suspended Solids*	7.00	5.60
pH*	Within the range of 7.0 to 10.0 at all times.	

Continuous Rod Casting - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.039	0.016
119 Chromium*	0.072	0.029
120 Copper	0.248	0.118
121 Cyanide*	0.039	0.016
122 Lead	0.054	0.025
124 Nickel	0.107	0.072
125 Selenium	0.159	0.072
128 Zinc*	0.198	0.081
Aluminum*	1.184	0.526
Oil & Grease*	1.940	1.940
Total Suspended Solids*	2.91	2.33
pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-6 (Continued)

NSPS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Continuous Rod Casting - Spent Lubricant

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.00039	0.00016
119 Chromium*	0.0008	0.0003
120 Copper	0.0025	0.0012
121 Cyanide*	0.0004	0.0002
122 Lead	0.00055	0.00026
124 Nickel	0.0011	0.00073
125 Selenium	0.0016	0.00073
128 Zinc*	0.0020	0.0008
Aluminum*	0.012	0.0053
Oil & Grease*	0.020	0.020
Total Suspended Solids*	0.030	0.024
pH*	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched		
118 Cadmium	0.407	0.163
119 Chromium*	0.754	0.31
120 Copper	2.607	1.243
121 Cyanide*	0.408	0.16
122 Lead	0.571	0.265
124 Nickel	1.120	0.754
125 Selenium	1.670	0.754
128 Zinc*	2.08	0.86
Aluminum*	12.446	5.520
Oil & Grease*	20.37	20.37
Total Suspended Solids*	30.56	24.450
pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-6 (Continued)

NSPS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Cleaning or Etching - Bath

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched	
118 Cadmium	0.036	0.014
119 Chromium*	0.066	0.027
120 Copper	0.229	0.109
121 Cyanide*	0.036	0.015
122 Lead	0.050	0.023
124 Nickel	0.099	0.066
125 Selenium	0.147	0.066
128 Zinc*	0.183	0.075
Aluminum*	1.094	0.485
Oil & Grease*	1.79	1.79
Total Suspended Solids*	2.69	2.15
pH*	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched	
118 Cadmium	0.278	0.111
119 Chromium*	0.515	0.21
120 Copper	1.781	0.849
121 Cyanide*	0.278	0.11
122 Lead	0.390	0.181
124 Nickel	0.765	0.515
125 Selenium	1.140	0.515
128 Zinc*	1.42	0.59
Aluminum*	8.50	3.77
Oil & Grease*	13.91	13.91
Total Suspended Solids*	20.87	16.70
pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

Table XI-6 (Continued)

NSPS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.387	0.154
119	Chromium*	0.72	0.290
120	Copper	2.474	1.179
121	Cyanide*	0.387	0.155
122	Lead	0.541	0.251
124	Nickel	1.063	0.715
125	Selenium	1.585	0.715
128	Zinc*	1.97	0.812
	Aluminum*	11.81	5.24
	Oil & Grease*	19.33	19.33
	Total Suspended Solids*	29.00	23.20
	pH*	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

SECTION XII

PRETREATMENT STANDARDS

Section 307(b) of the Clean Water Act requires EPA to promulgate pretreatment standards for existing sources (PSES), which must be achieved within three years of promulgation. PSES are designed to prevent the discharge of pollutants which pass through, interfere with, or are otherwise incompatible with the operation of publicly owned treatment works (POTW). The Clean Water Act of 1977 adds a new dimension by requiring pretreatment for pollutants, such as heavy metals, that limit POTW sludge management alternatives, including the beneficial use of sludges on agricultural lands. The legislative history of the 1977 Act indicates that pretreatment standards are to be technology based, analogous to the best available technology for removal of toxic pollutants.

Section 307(c) of the Act requires EPA to promulgate pretreatment standards for new sources (PSNS) at the same time that it promulgates NSPS. New indirect discharge facilities, like new direct discharge facilities, have the opportunity to incorporate the best available demonstrated technologies, including process changes, in-plant controls, and end-of-pipe treatment technologies, and to use plant site selection to ensure adequate treatment system installation.

General Pretreatment Regulations for Existing and New Sources of Pollution were published in the Federal Register, Vol. 43, No. 123, Monday, June 26, 1978 and amended on January 28, 1981 (46 FR 9404). These regulations describe the Agency's overall policy for establishing and enforcing pretreatment standards for new and existing users of a POTW and delineate the responsibilities and deadlines applicable to each party in this effort. In addition, 40 CFR Part 403, Section 403.5(b), outlines prohibited discharges which apply to all users of a POTW.

This section describes the treatment and control technology for pretreatment of process wastewaters from existing sources and new sources, and presents mass discharge limitations of regulated pollutants for existing and new sources, based on the described control technology.

INTRODUCTION OF ALUMINUM FORMING WASTEWATER INTO POTW

There are 72 plants in the aluminum forming industry which discharge to a POTW. The plants that may be affected by pretreatment standards represent about 27 percent of the aluminum forming plants.

Pretreatment standards are established to ensure removal of pollutants which interfere with, pass through, or are otherwise incompatible with a POTW. A determination of which pollutants may pass through or be incompatible with POTW operations, and thus be subject to pretreatment standards, depends on the level of treatment employed by the POTW. In general, more pollutants will pass through or interfere with a POTW employing primary treatment (usually physical separation by settling) than one which has installed secondary treatment (settling plus biological treatment).

Many of the pollutants contained in aluminum forming wastewaters are not biodegradable and are, therefore, ineffectively treated by such systems. Furthermore, these pollutants have been shown to pass through or interfere with the normal operations of these systems. Problems associated with the uncontrolled release of pollutant parameters identified in aluminum forming process wastewaters to POTW were discussed in Section VI. The discussion covered pass-through, interference, and sludge useability.

The Agency based the selection of pretreatment standards for the aluminum forming category on the minimization of pass-through of toxic pollutants at POTW. For each subcategory, the Agency compared BAT removal rates for each toxic pollutant limited by BAT to the national average removal rate for that pollutant at well operated POTW achieving secondary treatment. The POTW removal rates were determined through a study conducted by the Agency at over 40 POTW and a statistical analysis of the data. (See Fate of Priority Pollutants in Publicly Owned Treatment Works, EPA 440/1-80-301, October, 1980; and Determining National Removal Credits for Selected Pollutants for Publicly Owned Treatment Works, EPA 440/82-008, September, 1982.) The POTW removal rates of the major toxic pollutants found in aluminum forming wastewater are presented in Table XII-1.

The national average percentage of the toxic metals removed by a well-operated POTW meeting secondary treatment requirements is about 50 percent (varying from 20 to 65 percent), whereas the percentage that can be removed by an aluminum forming direct discharger applying the best available technology economically achievable is about 97 percent (ranging from 79 to 97 percent). Accordingly, these pollutants pass through a POTW. Specific percent removals for the BAT/PSES technology are shown below.

PSES Option 2 Removal Toxic Pollutant	Rate
Chromium	99.8%
Copper	85.4%
Cyanide	87.8%
Lead	93.7%
Nickel	66.9%
Zinc	96.2%
TTO	approximately 97%

The pretreatment options selected provide for significantly more removal of toxic pollutants than would occur if aluminum forming wastewaters were discharged untreated to POTW.

In addition to pass through of toxic metals, available information shows that many of the toxic organics from aluminum forming facilities also pass through a POTW. As previously mentioned, toxic organics are not specifically regulated at BAT because, for direct dischargers, the BPT oil and grease limit will effectively control toxic organics. As demonstrated by the data presented in Sections VII and X (Table X-26, p. 1111) and Table XII-1, direct dischargers who comply with the BPT limitation for oil and grease will remove a greater percentage of the toxic organics than a well operated POTW achieving secondary treatment. POTW removal of those toxic organic pollutants found in well operated POTW meeting secondary treatment requirements averaged 71 percent; while the oil skimming component of the BPT technology removes 97 percent. Accordingly, EPA is promulgating a pretreatment standard for toxic organics.

The Agency is regulating toxic organics as total toxic organics (TTO) which is comprised of all those toxic organics that were found to be present in sampled aluminum forming wastewaters at concentrations greater than the quantification level of 0.01 mg/l. Table XII-1 presents all of the total toxic organics as well as the toxic metals.

The analysis of wastewaters for toxic organics is costly and requires sophisticated equipment. Data indicate that the toxic organics are in the oil and grease and by removing the oil and grease, the toxic organics should also be removed. Therefore, the Agency is promulgating monitoring for oil and grease as an alternative to monitoring for TTO.

The pretreatment options selected provide for significantly more removal of toxic pollutants than would occur if aluminum forming wastewaters were discharged untreated to a POTW. Thus, pretreatment standards will control the discharge of toxic pollutants to POTW and prevent pass-through.

TECHNICAL APPROACH TO PRETREATMENT

The pretreatment options for existing sources and new sources are identical to the options considered for BAT which are discussed in Section X of this document. Pretreatment Options 4, 5, and 6 have high costs and high energy requirements and achieve only a small incremental removal of primarily toxic organics over removals achieved by pretreatment Options 2 and 3. The principle difference in pollutant removal achievable by Options 4, 5, and 6 over Options 2 and 3 are toxic organics. As shown in Section X (Table X-26, p. 1111), oil removal to the BPT level can achieve a 97 percent reduction in toxic organic pollutants. Therefore, Options 4, 5, and 6 were not further considered for PSES. There is no reason to believe that the levels of toxic organics discharged from new sources will be any different than from existing sources. Thus, Options 4, 5, and 6 were not further considered for PSNS.

Treatment technologies and controls employed for the pretreatment options are:

Pretreatment Option 1 is based on:

Oil skimming,

Lime and settle, and where required:

Chromium reduction,

Cyanide removal, and

Chemical emulsion breaking.

Pretreatment Option 2 is based on:

All of Pretreatment Option 1, plus

Countercurrent rinsing of cleaning or etching rinses to reduce normalized discharge flows.

Alternative fluxing methods (e.g., dry air pollution control and in-line refining) to eliminate the discharge from degassing operations.

Recycling of heat treatment contact cooling water streams through cooling towers to reduce their normalized discharge flow.

Recycling of air pollution control system streams associated with cleaning or etching and forging operations to reduce their their normalized discharge flows.

Use of extrusion die cleaning rinse for bath make-up water.

Pretreatment Option 3 is based on:

All of Pretreatment Option 2, plus multimedia filtration.

PSES AND PSNS OPTION SELECTION

In the aluminum forming category, the Agency has concluded that the pollutants that would be regulated, primarily toxic metals and organic under these proposed standards, pass through a POTW. The average percentage of these pollutants removed by a well-operated POTW meeting secondary treatment requirements nationwide is about 50 percent (ranging from 20 to 65 percent), whereas the percentage that can be removed by an aluminum forming direct discharger applying the best available technology economically achievable is expected to be about 98 percent (ranging from 79 to 97 percent). Accordingly, these pollutants pass through a POTW. Pass-through and concentration in POTW sludges are discussed in detail in Section VI for each toxic pollutant (organics and metals) that was considered for regulation under pretreatment standards.

Pretreatment Option 2 is selected as the regulatory approach for pretreatment standards for existing sources on the basis that it achieves effective removal of toxic pollutants and is economically achievable. In addition, as discussed above, a well-operated POTW can achieve removal of the pollutants that are discharged after the application of Pretreatment Option 2 technology. As summarized above in this section and in more detail in Section X, the basis of Pretreatment Option 2 (BAT Option 2) is reduction of flow for many of the waste streams associated with aluminum forming operations.

Pretreatment Option 3 is selected as the regulatory approach for pretreatment standards for new sources on the basis that new sources have the opportunity to design the most efficient process water use and wastewater reduction techniques within their processes thereby reducing the size of and cost of filtration equipment. As summarized above in this section and in more detail in Section X, the basis of Pretreatment Option 3 (BAT Option 3) is reduction or elimination of flow for many of the waste streams associated with aluminum forming operations and the application of filtration technology prior to final discharge.

The Agency believes that compliance costs could be lower for new sources than the cost estimates for equivalent existing sources, because production processes can be designed on the basis of lower flows and there will be no costs associated with retrofitting the in-process controls. Therefore, new sources regardless of whether they are plants with major modifications or greenfield sites, will have costs that are not greater than the costs that existing sources would incur in achieving equivalent pollutant discharge reduction. Based on this the Agency believes that the selected PSNS (Pretreatment Option 3) is appropriate for both greenfield sites and existing sites undergoing major modifications (e.g., a primary aluminum plant which installs a rolling operation).

Costs and Environmental Benefits of Treatment Options

As a means of evaluating the economic achievability of each of these options, the Agency developed estimates of the compliance costs and benefits for normal plants. Estimates of capital and annual costs for the pretreatment options were prepared for each subcategory as an aid in choosing the best pretreatment option. The cost estimates for indirect dischargers are presented in Table XII-2. In order to evaluate new sources a normal plant was developed for each subcategory. The characteristics of a normal plant are shown on Tables VIII-12 through VIII-17 (pp. 399-410). The normal plant costs are presented on Table VIII-18 (p. 412).

The cost methodology has been described in detail in Sections VIII and X. The benefit methodology has been described in detail in Section X. The pollutant reduction benefit estimates for all six subcategories are presented in Tables XII-3 through XII-8.

REGULATED POLLUTANT PARAMETERS

The same pollutants have been selected for regulation under the pretreatment standards for each of the six subcategories. The toxic metals selected are chromium (total), cyanide (total), and zinc. Aluminum is not limited because aluminum in its hydroxide form is used by POTW as a flocculant to aid in the settling and removal of suspended solids. Therefore, aluminum in limited quantities, does not pass through or interfere with a POTW; rather it is a necessary aid to its operation. TSS is not regulated since it is adequately handled by a POTW and will not interfere with their operation.

Toxic organic pollutants found in aluminum forming wastewaters may pass through a POTW; therefore, the Agency proposes to establish a pretreatment limitation on the discharge of total toxic organics (TTO) to a POTW. This limitation is based on the effluent concentrations presented in Table X-26 (p. 1111) and discussed in Section X under Regulated Pollutant Parameters (p. 1058). This limitation is achievable by treatment technologies that effectively remove oil and grease. Analysis of toxic organics is costly and requires delicate and sensitive equipment. Therefore, the Agency proposes to establish as an alternative to monitoring for total toxic organics an oil and grease limit for which the analysis is much less costly and frequently can be done at the plant.

PRETREATMENT STANDARDS

PSES for this category are expressed in terms of mass per unit of production (mass-based) rather than concentration standards. Regulation on the basis of concentration is not appropriate for this category because flow reduction is a significant part of the model technology for pretreatment. Therefore, the Agency is not proposing concentration-based pretreatment standards (40 CFR Part 403.6) for this category.

The regulatory production normalized flows for PSES are equivalent to BAT flows. The regulatory production normalized flows for PSNS are equivalent to the NSPS flows.

PSES are based on the treatment effectiveness values for lime and settle technology, as presented in Table VII-20 (p. 807). PSNS are based on the treatment effectiveness values for lime, settle, and filter technology, as presented in Table VII-20. The mass of pollutant allowed to be discharged per mass of product is calculated by multiplying the appropriate effectiveness value (one day maximum and ten day average values) (mg/l) by the production normalized flow (l/kkg). The PSES values are presented for each of the six subcategories in Tables XII-9 through XII-14. The PSNS values are presented for each of the six subcategories in Tables XII-15 through XII-20. The Agency recognizes that very few of the 72 indirect dischargers currently have BAT level treatment-in-place. Therefore, it is anticipated that plants will require three years to be in compliance with the pretreatment standards.

Table XII-1

POTW REMOVALS OF THE TOXIC POLLUTANTS FOUND IN ALUMINUM FORMING WASTEWATER

	Pollutant	Percent Removal By Secondary POTW
1.	Acenaphthene	NA
11.	1,1,1-Trichloroethane	87
13.	1,1-Dichloroethane	76
22.	p-Chloro-m-Cresol	89
24.	2-Chlorophenol	50
29.	1,1-Dichloroethylene	80
30.	1,2-Trans-Dichloroethylene	72
34.	2,4-Dimethylphenol	59
35.	2,4-Dinitrotoluene	NA
37.	1,2-Diphenylhydrazine	NA
38.	Ethylbenzene	84
39.	Fluoranthene	NA
54.	Isophorone	NA
55.	Naphthalene	61
62.	N-Nitrosodiphenylamine	NA
65.	Phenol	96
66.	Bis(2-Ethylhexyl) Phthalate	62
67.	Butyl Benzyl Phthalate	59
68.	Di-n-Butyl Phthalate	48
69.	Di-n-Octyl Phthalate	81
70.	Diethyl Phthalate	50
71.	Dimethyl Phthalate	74
72.	1,2-Benzanthracene	NA
73.	Benzo (a) Pyrene	NA
74.	3,4-Benzofluoranthene	NA
76.	Chrysene	NA
77.	Acenaphthalene	NA
78.	Anthracene	65
79.	1,12-Benzoperylene (Benzo(ghi)perylene)	83
80.	Fluorene	NA
81.	Phenathrene	65
82.	1,2,5,6-Dibenzanthracene	NA
83.	Indeno (1,2,3-cd) Pyrene	NA
84.	Pyrene	40
85.	Tetrachloroethylene	81
86.	Toluene	90
87.	Trichloroethylene	85
88.	Vinyl Chloride	94
97.	Endosulfan Sulfate	NA
98.	Endrin	NA
99.	Endrin Aldehyde	NA

Table XII-1 (Continued)

POTW REMOVALS OF THE TOXIC POLLUTANTS FOUND IN ALUMINUM FORMING WASTEWATER

	Pollutant	Percent Removal By Secondary POTW
106.	PCB-1242 (Arochlor 1242)	NA
107.	PCB-1254 (Arochlor 1254)	NA
108.	PCB-1221 (Arochlor 1221)	NA
109.	PCB-1232 (Arochlor 1232)	NA
110.	PCB-1248 (Arochlor 1248)	NA
111.	PCB-1260 (Arochlor 1260)	NA
112.	PCB-1016 (Arochlor 1016)	NA
119.	Chromium, hexavalent	18
	Chromium, trivalent	NA
120.	Copper	58
121.	Cyanide	52
122.	Lead	48
124.	Nickel	19
125.	Selenium	46
126.	Silver	66
128.	Zinc	65

NA - Not Available.

NOTE: This data compiled from Fate of Priority Pollutants In Publicly Owned Treatment Works, USEPA, EPA No. 440/1-80-301, October 1980.

Table XII-2

CAPITAL AND ANNUAL COST ESTIMATES FOR BAT OPTIONS
INDIRECT DISCHARGERS ($1982)

Subcategory	Option 1	Option 2	Option 3	Option 4*	Option 5*	Option 6*
Rolling with Neat Oils						
Capital	3,942,033	3,715,900	4,315,800	3,182,800	3,662,000	-
Annual	2,517,284	2,003,700	2,205,300	1,605,000	1,711,000	-
Rolling with Emulsions						
Capital	700,510	1,421,700	1,629,500	1,226,100	1,378,500	-
Annual	754,415	738,500	806,700	722,100	775,500	-
Extrusion						
Capital	13,457,685	16,167,813	17,757,218	11,377,300	12,379,000	-
Annual	12,470,437	13,544,148	14,169,862	5,863,000	6,071,800	-
Forging						
Capital	11,452,866	4,871,590	5,342,132	3,563,000	3,905,400	3,937,200
Annual	8,283,595	2,315,186	2,442,205	1,717,500	1,809,300	1,858,900
Drawing with Neat Oils						
Capital	1,661,364	1,752,034	1,908,904	1,021,500	1,106,200	-
Annual	1,191,096	961,270	1,014,478	493,700	517,900	-
Drawing with Emulsions or Soaps						
Capital	320,430	209,900	225,400	367,300	378,900	-
Annual	343,317	94,709	98,801	188,800	191,900	-
Totals						
Capital	31,534,888	28,138,937	31,178,954			
Annual	25,560,144	19,657,513	20,737,346			

*Costs for Options 4, 5, and 6 are given in 1978 dollars. Costs for Options 4, 5, and 6 were not revised for promulgation.

Table XII-3

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS ROLLING WITH NEAT OILS SUBCATEGORY

	Pollutant	Raw Waste	Option 1		Option 2	
	Flow (l/yr)	110.9 x 10^6	110.9 x 10^6		38.04 x 10^6	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.6	0.0	0.6	0.0	0.6
119.	Chromium	185.1	176.2	8.9	182.0	3.0
120.	Copper	32.6	0.0	32.6	10.5	22.1
121.	Cyanide	1.0	0.0	1.0	0.0	1.0
122.	Lead	142.0	128.7	13.3	137.4	4.6
124.	Nickel	4.9	0.0	4.9	0.0	4.9
128.	Zinc	33.9	0.6	33.3	22.5	11.4
	Aluminum	910.4	787.2	123.1	868.1	42.2
	Oil and Grease	172,645.5	171,536.3	1,109.2	172,265.1	380.4
	TSS	20,546.8	19,215.8	1,331.0	20,090.3	456.5
	Total Toxic Organics	259.0	257.3	1.7	258.4	0.6
	Total Toxic Metals	399.1	305.5	93.6	352.4	46.6
	Total Toxics	659.1	562.8	96.3	610.8	48.2
	Total Conventionals	193,192.3	190,752.1	2,440.2	192,355.4	836.9
	Total Pollutants	194,761.8	192,102.1	2,659.6	193,834.3	927.3
	Sludge	-----	979,440		990,160	

Table XII-3 (Continued)

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS
ROLLING WITH NEAT OILS SUBCATEGORY

	Pollutant	Option 3		Option 4		Option 5	
	Flow (l/yr)	38.04×10^6		28.30×10^6		28.30×10^6	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	0.6	0.0	0.6	0.0	0.6
119.	Chromium	182.4	2.7	182.8	2.3	183.1	2.0
120.	Copper	17.7	14.8	16.1	16.4	21.5	11.0
121.	Cyanide	0.0	1.0	0.0	1.0	0.0	1.0
122.	Lead	138.9	3.0	138.6	3.4	139.7	2.3
124.	Nickel	0.0	4.9	0.0	4.9	0.0	4.9
128.	Zinc	25.1	8.7	25.4	8.5	27.4	6.5
	Aluminum	882.2	28.1	878.9	31.4	889.4	20.9
	Oil and Grease	172,265.1	380.4	172,362.5	283.0	172,362.5	283.0
	TSS	20,447.9	98.9	20,207.1	339.7	20,473.2	73.6
	Total Toxic Organics	258.4	0.6	258.5	0.4	258.5	0.4
	Total Toxic Metals	364.1	34.7	362.9	36.1	371.7	27.3
	Total Toxics	622.5	36.3	621.4	37.5	630.2	28.7
	Total Conventionals	192,713.0	479.3	192,569.6	622.7	192,835.7	356.6
	Total Pollutants	194,217.7	543.7	194,069.9	691.6	194,355.3	406.2
	Sludge	992,450		991,630		993,340	

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table XII-4

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS
ROLLING WITH EMULSIONS SUBCATEGORY

	Pollutant	Raw Waste	Option 1		Option 2	
	Flow (l/yr)	2.696×10^9	972.9×10^6		665.4×10^6	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	4.9	0.0	4.9	0.0	4.9
119.	Chromium	739.8	665.4	74.4	687.0	52.8
120.	Copper	406.9	0.0	406.9	23.3	383.6
121.	Cyanide	20.5	0.0	20.5	0.0	20.5
122.	Lead	1,122.7	1,010.3	112.4	1,042.6	80.1
124.	Nickel	65.5	0.0	65.5	0.0	65.5
128.	Zinc	886.2	607.4	278.9	688.1	198.2
	Aluminum	30,568.2	29,315.7	1,252.5	29,614.3	953.9
	Oil and Grease	571,803.8	561,944.9	9,858.9	564,635.1	7,168.7
	TSS	331,656.5	319,981.0	11,675.4	323,209.3	8,447.2
	Total Toxic Organics	857.7	842.9	14.8	847.0	10.8
	Total Toxic Metals	3,226.0	2,283.1	943.0	2,441.0	785.1
	Total Toxics	4,104.2	3,126.0	978.3	3,288.0	816.4
	Total Conventionals	903,460.3	881,925.9	21,534.3	887,844.4	15,615.9
	Total Pollutants	938,132.7	914,367.6	23,765.1	920,746.7	17,386.2
	Sludge	-----	5,259,360		5,298,860	

Table XII-4 (Continued)

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS
ROLLING WITH EMULSIONS SUBCATEGORY

	Pollutant	Option 3		Option 4		Option 5	
	Flow (l/yr)	665.4 x 10^6		640.1 x 10^6		640.1 x 10^6	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	4.9	0.0	4.9	0.0	4.9
119.	Chromium	693.6	46.2	689.0	50.8	695.3	44.5
120.	Copper	148.8	258.1	38.0	368.9	158.7	248.2
121.	Cyanide	0.0	20.5	0.0	20.5	0.0	20.5
122.	Lead	1,069.0	53.7	1,045.6	77.1	1,071.0	51.7
124.	Nickel	0.0	65.5	0.0	65.5	0.0	65.5
128.	Zinc	734.3	151.9	695.7	190.6	740.1	146.1
	Aluminum	29,858.7	709.5	29,642.4	925.8	29,877.5	690.7
	Oil and Grease	564,635.1	7,168.7	564,888.5	6,915.4	564,888.5	6,915.4
	TSS	329,418.8	2,237.7	323,513.4	8,143.1	329,484.7	2,171.8
	Total Toxic Organics	847.0	10.8	847.3	10.4	847.3	10.4
	Total Toxic Metals	2,645.7	580.3	2,468.3	757.8	2,665.1	560.9
	Total Toxics	3,492.7	611.6	3,315.6	788.7	3,512.4	591.8
	Total Conventionals	894,053.9	9,406.4	888,401.9	15,058.5	894,373.2	9,087.2
	Total Pollutants	927,405.3	10,727.5	921,359.9	16,773.0	927,763.1	10,369.7
	Sludge	5,338,630		5,302,690		5,340,930	

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table XII-5

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS
EXTRUSION SUBCATEGORY

	Pollutant	Raw Waste	Option 1		Option 2	
	Flow (l/yr)	6.077×10^9	4.693×10^9		1.323×10^9	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	25.0	0.0	25.0	0.0	25.0
119.	Chromium	88,809.2	88,450.1	359.1	88,713.3	95.9
120.	Copper	3,553.6	944.7	2,608.9	2,859.2	694.4
121.	Cyanide	1,020.7	702.1	318.6	935.9	84.8
122.	Lead	1,211.2	665.7	545.5	1,064.0	147.2
124.	Nickel	1,872.5	0.0	1,872.5	1,190.4	682.1
128.	Zinc	6,331.7	4,967.9	1,363.8	5,978.6	353.1
	Aluminum	557,529.8	549,523.9	8,005.9	555,705.2	1,824.6
	Oil and Grease	181,646.6	133,426.0	48,220.6	166,972.6	14,674.0
	TSS	655,707.9	597,128.8	58,579.1	639,393.3	16,314.6
	Total Toxic Organics	272.4	200.1	72.3	250.5	21.9
	Total Toxic Metals	101,803.0	94,724.5	7,078.5	99,907.0	1,896.0
	Total Toxics	103,096.2	95,626.8	7,469.4	101,093.4	2,002.8
	Total Conventionals	837,354.5	730,554.8	106,799.7	806,365.9	30,988.6
	Total Pollutants	1,497,980.5	1,375,705.6	122,274.9	1,463,164.5	34,816.0
	Sludge	-----	34,539,900		35,023,250	

Table XII-5 (Continued)

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS
EXTRUSION SUBCATEGORY

	Pollutant	Option 3		Option 4*		Option 5*	
	Flow (l/yr)	1.323 x 10^9		7.673 x 10^9		7.673 x 10^9	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	25.0	0.0	22.0	0.0	22.0
119.	Chromium	88,725.3	83.9	78,140.9	84.4	78,151.5	73.8
120.	Copper	3,087.3	466.3	2,516.6	613.6	2,716.9	413.2
121.	Cyanide	963.5	57.2	823.5	75.6	847.8	51.3
122.	Lead	1,112.0	99.2	936.3	130.4	978.5	88.3
124.	Nickel	1,610.6	261.9	1,048.3	601.1	1,417.3	232.0
128.	Zinc	1,062.7	269.0	5,260.7	316.4	5,334.5	242.5
	Aluminum	556,149.4	1,380.4	489,920.7	2,165.2	489,310.9	1,775.0
	Oil and Grease	106,972.6	14,674.0	146,922.1	13,076.7	146,922.1	13,076.7
	TSS	0,643.6	5,064.3	562,569.3	14,994.1	572,481.7	5,081.8
	Total Toxic Organics	250.5	21.9	220.4	19.6	220.4	19.6
	Total Toxic Metals	100,699.6	1,103.4	87,902.8	1,767.9	88,598.7	1,071.8
	Total Toxics	101,913.6	1,182.6	88,946.7	1,863.1	89,666.9	1,142.7
	Total Conventionals	817,650.3	19,704.2	709,491.4	28,070.8	719,403.8	18,158.5
	Total Pollutants	1,675,713.2	22,267.3	1,287,358.8	32,099.1	1,298,381.6	21,076.2
	Sludge	68,482,400		68,057,960		68,515,120	

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

*Benefits for Options 4 and 5 were not revised for promulgation.

Table XII-6

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS
FORGING SUBCATEGORY

	Pollutant	Raw Waste	Option 1		Option 2	
	Flow (l/yr)	2.166×10^9	2.166×10^9		279.8×10^6	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	12.9	0.0	12.9	0.0	12.9
119.	Chromium	4,282.9	4,180.4	102.4	4,268.5	14.4
120.	Copper	3,515.1	2,763.5	751.6	3,401.6	113.4
121.	Cyanide	40.1	0.0	40.1	19.5	20.6
122.	Lead	1,555.2	1,383.8	171.4	1,515.8	39.3
124.	Nickel	585.4	0.0	585.4	482.6	102.8
128.	Zinc	7,292.8	6,908.6	384.2	7,238.7	54.1
	Aluminum	437,108.0	431,169.6	5,938.3	432,390.9	4,717.1
	Oil and Grease	45,262.6	20,932.9	24,329.7	31,935.5	13,327.1
	TSS	316,272.2	290,255.9	26,016.3	303,459.0	12,813.2
	Total Toxic Organics	82.7	31.4	51.3	47.9	34.8
	Total Toxic Metals	17,244.3	15,236.3	2,007.9	16,907.2	336.9
	Total Toxics	17,367.1	15,267.7	2,099.3	16,974.6	392.3
	Total Conventionals	361,534.8	311,188.8	50,346.0	335,394.5	26,140.3
	Total Pollutants	816,009.9	757,626.1	58,383.6	784,760.0	31,249.7
	Sludge	-----	13,832,780		14,017,230	

Table XII-6 (Continued)

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS
FORGING SUBCATEGORY

Pollutant	Option 3	
Flow (l/yr)	279.8 x 10^6	
	Removed (kg/yr)	Discharged (kg/yr)
Cadmium	4.1	8.8
Chromium	4,270.3	12.6
Copper	3,435.9	79.2
Cyanide	23.6	16.5
Lead	1,523.0	32.1
Nickel	545.7	39.7
Zinc	7,251.3	41.5
Aluminum	432,457.6	4,650.3
Oil and Grease	31,935.5	13,327.1
TSS	305,154.2	11,118.0
Total Toxic Organics	47.9	34.8
Total Toxic Metals	17,030.3	213.9
Total Toxics	17,101.8	265.2
Total Conventionals	337,089.7	24,445.1
Total Pollutants	786,649.1	29,360.6
	14,030,570	

Table XII-6 (Continued)

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS
FORGING SUBCATEGORY

	Pollutant	Option 4		Option 5		Option 6	
	Flow (l/yr)	279.5×10^6		279.5×10^6		279.5×10^6	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	12.9	4.1	8.8	4.1	8.8
119.	Chromium	4,268.5	14.4	4,270.3	12.6	4,270.3	12.6
120.	Copper	3,401.8	113.3	3,436.0	79.1	3,436.0	79.1
121.	Cyanide	19.5	20.6	23.7	16.4	23.7	16.4
122.	Lead	1,515.9	39.3	1,523.1	32.1	1,523.1	32.1
124.	Nickel	482.7	102.7	545.7	39.6	545.7	39.6
128.	Zinc	7,238.8	54.0	7,251.4	41.4	7,251.4	41.4
	Aluminum	432,391.2	4,716.8	432,457.8	4,650.1	432,457.8	4,650.1
	Oil and Grease	31,937.9	13,324.7	31,937.9	13,324.7	31,937.9	13,324.7
	TSS	303,461.9	12,810.3	305,154.8	11,117.4	305,154.8	11,117.4
	Total Toxic Organics	47.9	34.8	47.9	34.8	62.7	20.0
	Total Toxic Metals	16,907.7	336.6	17,030.6	213.6	17,030.6	213.6
	Total Toxics	16,975.1	392.0	17,102.2	264.8	17,117.0	250.0
	Total Conventionals	335,399.8	26,135.0	337,092.7	24,442.1	337,092.7	24,442.1
	Total Pollutants	784,766.1	31,243.8	786,652.7	29,357.0	786,667.5	29,342.2
	Sludge	14,017,280		14,030,600		14,030,600	

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table XII-7

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS
DRAWING WITH NEAT OILS SUBCATEGORY

	Pollutant	Raw Waste	Option 1		Option 2	
	Flow (l/yr)	557.4 x 10^6	557.4 x 10^6		79.78 x 10^6	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	3.2	0.0	3.2	0.0	3.2
119.	Chromium	5,216.3	5,188.0	28.2	5,211.7	4.5
120.	Copper	817.9	611.2	206.7	782.9	35.0
121.	Cyanide	59.0	32.5	26.5	53.2	5.8
122.	Lead	339.4	293.0	46.4	328.5	10.9
124.	Nickel	138.4	0.0	138.4	106.0	32.4
128.	Zinc	1,822.4	1,716.5	105.9	1,805.3	17.0
	Aluminum	103,424.0	101,990.4	1,434.3	102,319.1	1,105.6
	Oil and Grease	13,274.0	7,084.9	6,189.1	10,045.9	3,228.1
	TSS	77,365.4	70,672.3	6,693.1	74,225.5	3,139.9
	Total Toxic Organics	19.9	10.6	9.3	15.1	4.8
	Total Toxic Metals	8,337.6	7,808.7	528.8	8,234.4	103.0
	Total Toxics	8,416.5	7,851.8	564.6	8,302.7	113.6
	Total Conventionals	90,639.4	77,757.2	12,882.2	84,271.4	6,368.0
	Total Pollutants	202,479.9	187,599.4	14,881.1	194,893.2	7,587.2
	Sludge	-----	3,339,700		3,389,050	

Table XII-7 (Continued)

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS
DRAWING WITH NEAT OILS SUBCATEGORY

	Pollutant	Option 3		Option 4		Option 5	
	Flow (l/vr)	79.78×10^6		79.61×10^6		79.61×10^6	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.4	2.8	0.0	3.2	0.5	2.8
119.	Chromium	5,212.3	4.0	5,211.7	4.5	5,212.3	4.0
120.	Copper	793.7	24.2	783.0	34.9	793.8	24.1
121.	Cyanide	54.5	4.5	53.2	5.8	54.5	4.5
122.	Lead	330.8	8.6	328.5	10.9	330.8	8.6
124.	Nickel	125.9	12.5	106.1	32.3	126.0	12.5
128.	Zinc	1,809.3	13.1	1,805.4	17.0	1,809.3	13.0
	Aluminum	102,340.1	1,084.6	102,319.3	1,105.4	102,340.2	1,084.5
	Oil and Grease	10,045.9	3,228.1	10,047.7	3,226.3	10,047.7	3,226.3
	TSS	74,759.7	2,605.7	74,227.7	3,137.8	74,760.2	2,605.2
	Total Toxic Organics	15.1	4.8	15.1	4.8	15.1	4.8
	Total Toxic Metals	8,272.4	65.2	8,234.7	102.8	8,272.7	65.0
	Total Toxics	8,342.0	74.5	8,303.0	113.4	8,342.3	74.3
	Total Conventionals	84,805.6	5,833.8	84,275.4	6,364.1	84,807.9	5,831.5
	Total Pollutants	195,487.7	6,992.9	194,897.7	7,582.9	195,490.4	6,990.3
	Sludge	3,393,250		3,389,080		3,393,270	

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table XII-8

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS
DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

	Pollutant	Raw Waste	Option 1		Option 2	
	Flow (l/yr)	134.7×10^6	134.7×10^6		23.56×10^6	
		(kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.7	0.0	0.7	0.0	0.7
119.	Chromium	202.0	194.7	7.3	200.6	1.5
120.	Copper	175.1	121.7	53.4	163.8	11.3
121.	Cyanide	1.4	0.0	1.4	0.0	1.4
122.	Lead	77.1	65.2	11.8	73.9	3.1
124.	Nickel	29.4	0.0	29.4	18.8	10.7
128.	Zinc	358.0	330.7	27.4	352.4	5.6
	Aluminum	21,421.7	21,099.1	322.6	21,179.7	242.0
	Oil and Grease	11,793.2	10,316.0	1,477.2	11,041.9	751.4
	TSS	16,608.0	14,991.1	1,616.9	15,862.1	745.9
	Total Toxic Organics	17.7	15.5	2.2	16.6	1.1
	Total Toxic Metals	842.3	712.3	130.0	809.5	32.9
	Total Toxics	861.4	727.8	133.6	826.1	35.4
	Total Conventionals	28,401.2	25,307.1	3,094.1	26,904.0	1,497.3
	Total Pollutants	50,684.3	47,134.0	3,550.3	48,909.8	1,774.7
	Sludge	-----	726,980		738,630	

Table XII-8 (Continued)

POLLUTANT REDUCTION BENEFITS - INDIRECT DISCHARGERS
DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

	Pollutant	Option 3		Option 4		Option 5	
	Flow (l/yr)	23.56 x 10^6		21.30 x 10^6		21.30 x 10^6	
		Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)	Removed (kg/yr)	Discharged (kg/yr)
118.	Cadmium	0.0	0.7	0.0	0.7	0.0	0.7
119.	Chromium	200.7	1.3	200.7	1.3	200.9	1.1
120.	Copper	167.4	7.7	165.1	10.0	168.3	6.8
121.	Cyanide	0.1	1.3	0.0	1.4	0.2	1.2
122.	Lead	74.7	2.4	74.2	2.8	74.9	2.2
124.	Nickel	25.3	4.1	20.0	9.4	25.8	3.6
128.	Zinc	353.7	4.3	353.1	4.9	354.3	3.8
	Aluminum	21,186.6	235.1	21,182.2	239.5	21,188.3	233.4
	Oil and Grease	11,041.9	751.4	11,064.5	728.7	11,064.5	728.7
	TSS	16,037.8	570.2	15,889.3	718.7	16,043.6	564.3
	Total Toxic Organics	16.6	1.1	16.6	1.1	16.6	1.1
	Total Toxic Metals	821.8	20.5	813.1	29.1	824.2	18.2
	Total Toxics	838.5	22.9	829.7	31.6	841.0	20.5
	Total Conventionals	27,079.7	1,321.6	26,953.8	1,447.4	27,108.1	1,293.0
	Total Pollutants	49,104.8	1,579.6	48,965.7	1,718.5	49,137.4	1,546.9
	Sludge	739,990		739,010		740,220	

Note: Total Toxic Metals - Cadmium + Chromium + Copper + Lead + Nickel + Zinc
Total Toxics - Total Toxic Organics + Total Toxic Metals + Cyanide
Total Conventionals - Oil and Grease + TSS
Total Pollutants - Total Toxics + Total Conventionals + Aluminum

Table XII-9

PSES FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Rolling With Neat Oils - Core Waste Streams Without An Annealing Furnace Scrubber

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum rolled with neat oils			
118	Cadmium	0.019	0.008
119	Chromium*	0.025	0.010
120	Copper	0.105	0.055
121	Cyanide*	0.016	0.007
122	Lead	0.023	0.011
124	Nickel	0.106	0.070
125	Selenium	0.068	0.030
128	Zinc*	0.081	0.034
	Aluminum	0.356	0.177
	Total Toxic Organics (TTO)*	0.038	-
	Oil & Grease**	1.11	0.67
	Total Suspended Solids	2.268	1.078
	pH	Within the range of 7.0 to 10.0 at all times.	

Rolling With Neat Oils - Core Waste Streams With An Annealing Furnace Scrubber

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum rolled with neat oils			
118	Cadmium	0.028	0.012
119	Chromium*	0.036	0.015
120	Copper	0.155	0.082
121	Cyanide*	0.024	0.010
122	Lead	0.035	0.017
124	Nickel	0.157	0.104
125	Selenium	0.100	0.045
128	Zinc*	0.119	0.050
	Aluminum	0.525	0.261
	Total Toxic Organics (TTO)*	0.057	-
	Oil & Grease**	1.64	0.98
	Total Suspended Solids	3.348	1.592
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-9 (Continued)

PSES FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Continuous Sheet Casting - Spent Lubricant

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods			
118	Cadmium	0.0007	0.0003
119	Chromium*	0.00086	0.00035
120	Copper	0.0037	0.0020
121	Cyanide*	0.00057	0.00024
122	Lead	0.0008	0.0004
124	Nickel	0.0038	0.0025
125	Selenium	0.0024	0.0011
128	Zinc*	0.0029	0.0012
	Aluminum	0.0126	0.0063
	Total Toxic Organics (TTO)*	0.0014	-
	Oil & Grease*	0.040	0.024
	Total Suspended Solids	0.0805	0.0383
	pH	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched			
118	Cadmium	0.693	0.306
119	Chromium*	0.90	0.37
120	Copper	3.870	2.037
121	Cyanide*	0.59	0.25
122	Lead	0.856	0.408
124	Nickel	3.911	2.587
125	Selenium	2.506	1.120
128	Zinc*	2.98	1.25
	Aluminum	13.098	6.518
	Total Toxic Organics (TTO)*	1.41	-
	Oil & Grease**	40.74	24.45
	Total Suspended Solids	83.517	39.722
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-9 (Continued)

PSES FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Bath

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched	
118 Cadmium	0.061	0.027
119 Chromium*	0.079	0.032
120 Copper	0.340	0.179
121 Cyanide*	0.052	0.022
122 Lead	0.075	0.036
124 Nickel	0.344	0.227
125 Selenium	0.220	0.098
128 Zinc*	0.262	0.109
Aluminum	1.151	0.573
Total Toxic Organics (TTO)*	0.124	-
Oil & Grease**	3.58	2.15
Total Suspended Solids	7.339	3.491
pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched	
118 Cadmium	0.473	0.209
119 Chromium*	0.61	0.25
120 Copper	2.643	1.391
121 Cyanide*	0.41	0.17
122 Lead	0.584	0.278
124 Nickel	2.671	1.767
125 Selenium	1.711	0.765
128 Zinc*	2.03	0.85
Aluminum	8.944	4.451
Total Toxic Organics (TTO)*	0.96	-
Oil & Grease**	27.82	16.69
Total Suspended Solids	57.031	27.125
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-9 (Continued)

PSES FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched			
118	Cadmium	0.657	0.290
119	Chromium*	0.85	0.35
120	Copper	3.673	1.933
121	Cyanide*	0.56	0.23
122	Lead	0.812	0.387
124	Nickel	3.711	2.455
125	Selenium	2.378	1.063
128	Zinc*	2.82	1.18
	Aluminum	12.429	6.186
	Total Toxic Organics (TTO)*	1.34	-
	Oil & Grease**	38.7	23.20
	Total Suspended Solids	79.253	37.694
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-10

PSES FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Rolling With Emulsions - Core Waste Streams

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum rolled with emulsions		
118	Cadmium	0.044	0.019
119	Chromium*	0.057	0.024
120	Copper	0.247	0.130
121	Cyanide*	0.038	0.016
122	Lead	0.055	0.026
124	Nickel	0.249	0.165
125	Selenium	0.160	0.071
128	Zinc*	0.190	0.079
	Aluminum	0.835	0.415
	Total Toxic Organics (TTO)*	0.090	-
	Oil & Grease**	2.60	1.56
	Total Suspended Solids	5.323	2.531
	pH	Within the range of 7.0 to 10.0 at all times.	

Direct Chill Casting - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by direct chill methods			
118	Cadmium	0.452	0.199
119	Chromium*	0.59	0.24
120	Copper	2.525	1.329
121	Cyanide*	0.39	0.16
122	Lead	0.558	0.266
124	Nickel	2.552	1.688
125	Selenium	1.635	0.731
128	Zinc*	1.94	0.81
	Aluminum	8.545	4.253
	Total Toxic Organics (TTO)*	0.92	-
	Oil & Grease**	26.58	15.95
	Total Suspended Solids	54.589	25.916
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-10 (Continued)

PSES FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	0.693	0.306
119	Chromium*	0.90	0.37
120	Copper	3.870	2.037
121	Cyanide*	0.6	0.25
122	Lead	0.856	0.408
124	Nickel	3.911	2.587
125	Selenium	2.506	1.120
128	Zinc*	2.98	1.25
	Aluminum	13.098	6.518
	Total Toxic Organics (TTO)*	1.41	-
	Oil & Grease**	40.74	24.44
	Total Suspended Solids	83.517	39.722
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.262	0.109
	Aluminum	1.151	0.573
	Total Toxic Organics (TTO)*	0.124	-
	Oil & Grease**	3.58	2.15
	Total Suspended Solids	7.339	3.491
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-10 (Continued)

PSES FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Cleaning or Etching - Rinse

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.473	0.209
119	Chromium*	0.61	0.25
120	Copper	2.643	1.391
121	Cyanide*	0.41	0.17
122	Lead	0.584	0.278
124	Nickel	2.671	1.767
125	Selenium	1.711	0.765
128	Zinc*	2.03	0.85
	Aluminum	8.944	4.451
	Total Toxic Organics (TTO)*	0.96	-
	Oil & Grease**	27.82	16.69
	Total Suspended Solids	57.031	27.125
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.657	0.290
119	Chromium*	0.85	0.35
120	Copper	3.673	1.933
121	Cyanide*	0.56	0.23
122	Lead	0.812	0.387
124	Nickel	3.711	2.455
125	Selenium	2.378	1.063
128	Zinc*	2.83	1.18
	Aluminum	12.429	6.186
	Total Toxic Organics (TTO)*	1.34	-
	Oil & Grease**	38.66	23.20
	Total Suspended Solids	79.253	37.694
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-11

PSES FOR THE EXTRUSION SUBCATEGORY

Extrusion - Core Waste Streams

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum extruded		
118	Cadmium	0.116	0.051
119	Chromium*	0.15	0.061
120	Copper	0.646	0.340
121	Cyanide*	0.098	0.041
122	Lead	0.143	0.068
124	Nickel	0.653	0.432
125	Selenium	0.418	0.187
128	Zinc*	0.49	0.21
	Aluminum	2.187	1.088
	Total Toxic Organics (TTO)*	0.23	-
	Oil & Grease**	6.80	4.07
	Total Suspended Solids	13.944	6.632
	pH	Within the range of 7.0 to 10.0 at all times.	

Direct Chill Casting - Contact Cooling Water

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cast by direct chill methods		
118	Cadmium	0.452	0.199
119	Chromium*	0.59	0.24
120	Copper	2.525	1.329
121	Cyanide*	0.39	0.16
122	Lead	0.558	0.266
124	Nickel	2.552	1.688
125	Selenium	1.635	0.731
128	Zinc*	1.94	0.81
	Aluminum	8.545	4.253
	Total Toxic Organics (TTO)*	0.92	-
	Oil & Grease**	26.58	15.95
	Total Suspended Solids	54.489	25.916
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-11 (Continued)

PSES FOR THE EXTRUSION SUBCATEGORY

Solution and Press Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	0.693	0.306
119	Chromium*	0.90	0.37
120	Copper	3.870	2.037
121	Cyanide*	0.59	0.25
122	Lead	0.856	0.408
124	Nickel	3.911	2.587
125	Selenium	2.506	1.120
128	Zinc*	2.98	1.25
	Aluminum	13.098	6.518
	Total Toxic Organics (TTO)*	1.41	-
	Oil & Grease**	40.74	24.45
	Total Suspended Solids	83.517	39.722
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.26	0.109
	Aluminum	1.151	0.573
	Total Toxic Organics (TTO)*	0.124	-
	Oil & Grease**	3.58	2.15
	Total Suspended Solids	7.339	3.491
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-11 (Continued)

PSES FOR THE EXTRUSION SUBCATEGORY

Cleaning or Etching - Rinse

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched		
118 Cadmium	0.473	0.209
119 Chromium*	0.61	0.25
120 Copper	2.643	1.391
121 Cyanide*	0.41	0.17
122 Lead	0.584	0.278
124 Nickel	2.671	1.767
125 Selenium	1.711	0.765
128 Zinc*	2.03	0.85
Aluminum	8.944	4.451
Total Toxic Organics (TTO)*	0.96	-
Oil & Grease**	27.82	16.69
Total Suspended Solids	57.031	27.125
pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched		
118 Cadmium	0.657	0.290
119 Chromium*	0.85	0.35
120 Copper	3.673	1.933
121 Cyanide*	0.56	0.23
122 Lead	0.812	0.387
124 Nickel	3.711	2.455
125 Selenium	2.378	1.063
128 Zinc*	2.82	1.18
Aluminum	12.429	6.186
Total Toxic Organics (TTO)*	1.34	-
Oil & Grease**	38.66	23.20
Total Suspended Solids	79.253	37.694
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-11 (Continued)

PSES FOR THE EXTRUSION SUBCATEGORY

Degassing - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
		mg/kg (lb/million lbs) of aluminum degassed	
118	Cadmium	0.00	0.00
119	Chromium*	0.00	0.00
120	Copper	0.00	0.00
121	Cyanide*	0.00	0.00
122	Lead	0.00	0.00
124	Nickel	0.00	0.00
125	Selenium	0.00	0.00
128	Zinc*	0.00	0.00
	Aluminum	0.00	0.00
	Total Toxic Organics (TTO)*	0.00	-
	Oil & Grease**	0.00	0.00
	Total Suspended Solids	0.00	0.00
	pH	Within the range of 7.0 to 10.0 at all times.	

Extrusion Press Hydraulic Fluid Leakage

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
		mg/kg (lb/million lbs) of aluminum extruded	
118	Cadmium	0.503	0.222
119	Chromium*	0.65	0.27
120	Copper	2.808	1.478
121	Cyanide*	0.43	0.18
122	Lead	0.621	0.296
124	Nickel	2.838	1.877
125	Selenium	1.818	0.813
128	Zinc*	2.16	0.90
	Aluminum	9.504	4.730
	Total Toxic Organics (TTO)*	1.02	-
	Oil & Grease**	29.56	17.74
	Total Suspended Solids	60.598	28.821
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-12

PSES FOR THE FORGING SUBCATEGORY

Forging - Core Waste Streams

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
		mg/kg (lb/million lbs) of aluminum forged	
118	Cadmium	0.017	0.007
119	Chromium*	0.022	0.009
120	Copper	0.095	0.050
121	Cyanide*	0.015	0.006
122	Lead	0.021	0.010
124	Nickel	0.096	0.063
125	Selenium	0.061	0.027
128	Zinc*	0.073	0.031
	Aluminum	0.320	0.159
	Total Toxic Organics (TTO)*	0.035	-
	Oil & Grease**	1.00	0.60
	Total Suspended Solids	2.042	0.971
	pH	Within the range of 7.0 to 10.0 at all times.	

Forging - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
		mg/kg (lb/million lbs) of aluminum forged	
118	Cadmium	0.032	0.014
119	Chromium*	0.042	0.017
120	Copper	0.179	0.094
121	Cyanide*	0.028	0.011
122	Lead	0.040	0.019
124	Nickel	0.181	0.120
125	Selenium	0.116	0.052
128	Zinc*	0.14	0.058
	Aluminum	0.606	0.302
	Total Toxic Organics (TTO)*	0.065	-
	Oil & Grease**	1.89	1.13
	Total Suspended Solids	3.867	1.839
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-12 (Continued)

PSES FOR THE FORGING SUBCATEGORY

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
		mg/kg (lb/million lbs) of aluminum quenched	
118	Cadmium	0.693	0.306
119	Chromium*	0.897	0.37
120	Copper	3.870	2.037
121	Cyanide*	0.591	0.25
122	Lead	0.856	0.408
124	Nickel	3.911	2.587
125	Selenium	2.506	1.120
128	Zinc*	2.98	1.24
	Aluminum	13.098	6.518
	Total Toxic Organics (TTO)*	1.41	-
	Oil & Grease**	40.74	24.45
	Total Suspended Solids	83.517	39.722
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
		mg/kg (lb/million lbs) of aluminum cleaned or etched	
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.26	0.11
	Aluminum	1.151	0.573
	Total Toxic Organics (TTO)*	0.123	-
	Oil & Grease**	3.58	2.15
	Total Suspended Solids	7.339	3.491
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-12 (Continued)

PSES FOR THE FORGING SUBCATEGORY

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.473	0.209
119	Chromium*	0.61	0.25
120	Copper	2.643	1.391
121	Cyanide*	0.40	0.17
122	Lead	0.584	0.278
124	Nickel	2.671	1.767
125	Selenium	1.711	0.765
128	Zinc*	2.03	0.85
	Aluminum	8.944	4.451
	Total Toxic Organics (TTO)*	0.96	-
	Oil & Grease**	27.82	16.70
	Total Suspended Solids	57.031	27.125
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.657	0.290
119	Chromium*	0.851	0.35
120	Copper	3.673	1.933
121	Cyanide*	0.561	0.23
122	Lead	0.812	0.387
124	Nickel	3.711	2.455
125	Selenium	2.378	1.063
128	Zinc*	2.82	1.18
	Aluminum	12.429	6.186
	Total Toxic Organics (TTO)*	1.34	-
	Oil & Grease**	38.66	23.20
	Total Suspended Solids	79.253	37.694
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-13

PSES FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Drawing With Neat Oils - Core Waste Streams

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum drawn with neat oils		
118 Cadmium	0.017	0.007
119 Chromium*	0.022	0.009
120 Copper	0.097	0.050
121 Cyanide*	0.015	0.006
122 Lead	0.021	0.010
124 Nickel	0.096	0.063
125 Selenium	0.061	0.027
128 Zinc*	0.073	0.031
Aluminum	0.320	0.159
Total Toxic Organics (TTO)*	0.035	-
Oil & Grease**	1.00	0.60
Total Suspended Solids	2.042	0.971
pH	Within the range of 7.0 to 10.0 at all times.	

Continuous Rod Casting - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.066	0.029
119 Chromium*	0.086	0.035
120 Copper	0.368	0.194
121 Cyanide*	0.057	0.023
122 Lead	0.082	0.039
124 Nickel	0.372	0.246
125 Selenium	0.239	0.107
128 Zinc*	0.283	0.118
Aluminum	1.247	0.620
Total Toxic Organics (TTO)*	0.133	-
Oil & Grease**	3.878	2.327
Total Suspended Solids	7.950	3.781
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-13 (Continued)

PSES FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Continuous Rod Casting - Spent Lubricant

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.0007	0.0003
119 Chromium*	0.0009	0.0004
120 Copper	0.0037	0.0020
121 Cyanide*	0.0006	0.0003
122 Lead	0.0008	0.0004
124 Nickel	0.0038	0.0025
125 Selenium	0.0024	0.0011
128 Zinc*	0.0029	0.0012
Aluminum	0.0126	0.0063
Total Toxic Organics (TTO)*	0.0014	-
Oil & Grease**	0.040	0.024
Total Suspended Solids	0.0805	0.0383
pH	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched		
118 Cadmium	0.693	0.306
119 Chromium*	0.896	0.367
120 Copper	3.870	2.037
121 Cyanide*	0.591	0.245
122 Lead	0.856	0.408
124 Nickel	3.911	2.587
125 Selenium	2.506	1.120
128 Zinc*	2.98	1.24
Aluminum	13.098	6.518
Total Toxic Organics (TTO)*	1.41	-
Oil & Grease**	40.74	24.45
Total Suspended Solids	83.517	39.722
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-13 (Continued)

PSES FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.033
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.262	0.109
	Aluminum	1.151	0.573
	Total Toxic Organics (TTO)*	0.124	-
	Oil & Grease**	3.58	2.15
	Total Suspended Solids	7.339	3.491
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.473	0.209
119	Chromium*	0.612	0.251
120	Copper	2.643	1.391
121	Cyanide*	0.404	0.17
122	Lead	0.584	0.278
124	Nickel	2.671	1.767
125	Selenium	1.711	0.765
128	Zinc*	2.03	0.85
	Aluminum	8.944	4.451
	Total Toxic Organics (TTO)*	0.96	-
	Oil & Grease**	27.82	16.70
	Total Suspended Solids	57.031	27.125
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-13 (Continued)

PSES FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cleaned or etched		
118 Cadmium	0.657	0.290
119 Chromium*	0.851	0.348
120 Copper	3.673	1.933
121 Cyanide*	0.561	0.232
122 Lead	0.812	0.387
124 Nickel	3.711	2.455
125 Selenium	2.378	1.063
128 Zinc*	2.82	1.18
Aluminum	12.429	6.186
Total Toxic Organics (TTO)*	1.34	-
Oil & Grease**	38.66	23.20
Total Suspended Solids	79.253	37.694
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-14

PSES FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Drawing With Emulsions or Soaps - Core Waste Streams

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs)		of aluminum drawn with	emulsions or soaps
118	Cadmium	0.159	0.070
119	Chromium*	0.205	0.084
120	Copper	0.886	0.466
121	Cyanide*	0.135	0.056
122	Lead	0.196	0.093
124	Nickel	0.895	0.592
125	Selenium	0.574	0.256
128	Zinc*	0.681	0.285
	Aluminum	2.998	1.492
	Total Toxic Organics (TTO)*	0.32	-
	Oil & Grease**	9.33	5.60
	Total Suspended Solids	19.118	9.093
	pH	Within the range of 7.0 to 10.0 at all times.	

Continuous Rod Casting - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs)		of aluminum cast by	continuous methods
118	Cadmium	0.066	0.029
119	Chromium*	0.086	0.035
120	Copper	0.368	0.194
121	Cyanide*	0.056	0.024
122	Lead	0.082	0.039
124	Nickel	0.372	0.246
125	Selenium	0.239	0.107
128	Zinc*	0.283	0.119
	Aluminum	1.247	0.620
	Total Toxic Organics (TTO)*	0.134	-
	Oil & Grease**	3.88	2.33
	Total Suspended Solids	7.950	3.781
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-14 (Continued)

PSES FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Continuous Rod Casting - Spent Lubricant

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118	Cadmium	0.0007	0.0003
119	Chromium*	0.0009	0.0004
120	Copper	0.0037	0.0020
121	Cyanide*	0.0006	0.0003
122	Lead	0.0008	0.0004
124	Nickel	0.0038	0.0025
125	Selenium	0.0024	0.0011
128	Zinc*	0.0029	0.0012
	Aluminum	0.0126	0.0063
	Total Toxic Organics (TTO)*	0.0014	-
	Oil & Grease**	0.040	0.024
	Total Suspended Solids	0.0805	0.0383
	pH	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	0.693	0.306
119	Chromium*	0.896	0.367
120	Copper	3.870	2.037
121	Cyanide*	0.591	0.245
122	Lead	0.856	0.408
124	Nickel	3.911	2.587
125	Selenium	2.506	1.120
128	Zinc*	2.98	1.25
	Aluminum	13.098	6.518
	Total Toxic Organics (TTO)*	1.41	-
	Oil & Grease**	40.74	24.44
	Total Suspended Solids	83.517	39.722
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-14 (Continued)

PSES FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.061	0.027
119	Chromium*	0.079	0.032
120	Copper	0.340	0.179
121	Cyanide*	0.052	0.022
122	Lead	0.075	0.036
124	Nickel	0.344	0.227
125	Selenium	0.220	0.098
128	Zinc*	0.262	0.11
	Aluminum	1.151	0.573
	Total Toxic Organics (TTO)*	0.124	-
	Oil & Grease**	3.58	2.15
	Total Suspended Solids	7.339	3.491
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.473	0.209
119	Chromium*	0.612	0.251
120	Copper	2.643	1.391
121	Cyanide*	0.404	0.167
122	Lead	0.584	0.278
124	Nickel	2.671	1.767
125	Selenium	1.711	0.765
128	Zinc*	2.03	0.849
	Aluminum	8.944	4.451
	Total Toxic Organics (TTO)*	0.96	-
	Oil & Grease**	27.82	16.69
	Total Suspended Solids	57.031	27.125
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-14 (Continued)

PSES FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.657	0.290
119	Chromium*	0.851	0.348
120	Copper	3.673	1.933
121	Cyanide*	0.561	0.232
122	Lead	0.812	0.387
124	Nickel	3.711	2.455
125	Selenium	2.378	1.063
128	Zinc*	2.82	1.18
	Aluminum	12.429	6.186
	Total Toxic Organics (TTO)*	1.34	-
	Oil & Grease**	38.66	23.20
	Total Suspended Solids	79.253	37.694
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-15

PSNS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Rolling With Neat Oils - Core Waste Streams Without An Annealing Furnace Scrubber

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum rolled with neat oils		
118 Cadmium	0.011	0.004
119 Chromium*	0.021	0.009
120 Copper	0.071	0.034
121 Cyanide*	0.011	0.005
122 Lead	0.016	0.007
124 Nickel	0.030	0.021
125 Selenium	0.045	0.021
128 Zinc*	0.057	0.024
Aluminum	0.338	0.150
Total Toxic Organics (TTO)*	0.038	-
Oil & Grease**	0.54	0.54
Total Suspended Solids	0.830	0.664
pH	Within the range of 7.0 to 10.0 at all times.	

Rolling With Neat Oils - Core Waste Streams With An Annealing Furnace Scrubber

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum rolled with neat oils		
118 Cadmium	0.016	0.007
119 Chromium*	0.030	0.013
120 Copper	0.105	0.050
121 Cyanide*	0.017	0.007
122 Lead	0.023	0.011
124 Nickel	0.045	0.030
125 Selenium	0.070	0.030
128 Zinc*	0.084	0.035
Aluminum	0.499	0.221
Total Toxic Organics (TTO)*	0.057	-
Oil & Grease**	0.817	0.817
Total Suspended Solids	1.225	0.980
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-15 (Continued)

PSNS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Continuous Sheet Casting - Spent Lubricant

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.00039	0.00016
119 Chromium*	0.00073	0.00029
120 Copper	0.0025	0.0012
121 Cyanide*	0.00039	0.00016
122 Lead	0.0006	0.00026
124 Nickel	0.0011	0.00073
125 Selenium	0.0016	0.00073
128 Zinc*	0.0020	0.00082
Aluminum	0.012	0.0053
Total Toxic Organics (TTO)*	0.0014	-
Oil & Grease**	0.020	0.020
Total Suspended Solids	0.030	0.024
pH	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched		
118 Cadmium	0.407	0.163
119 Chromium*	0.76	0.31
120 Copper	2.607	1.243
121 Cyanide*	0.41	0.17
122 Lead	0.571	0.265
124 Nickel	1.120	0.754
125 Selenium	1.670	0.754
128 Zinc*	2.08	0.86
Aluminum	12.446	5.520
Total Toxic Organics (TTO)*	1.41	-
Oil & Grease**	20.37	20.37
Total Suspended Solids	30.555	24.444
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-15 (Continued)

PSNS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.036	0.014
119	Chromium*	0.067	0.027
120	Copper	0.229	0.109
121	Cyanide*	0.036	0.015
122	Lead	0.050	0.023
124	Nickel	0.099	0.066
125	Selenium	0.147	0.066
128	Zinc*	0.183	0.075
	Aluminum	1.094	0.485
	Total Toxic Organics (TTO)*	0.124	-
	Oil & Grease**	1.79	1.79
	Total Suspended Solids	2.685	2.148
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.278	0.111
119	Chromium*	0.52	0.21
120	Copper	1.781	0.849
121	Cyanide*	0.28	0.11
122	Lead	0.390	0.181
124	Nickel	0.765	0.515
125	Selenium	1.140	0.515
128	Zinc*	1.42	0.59
	Aluminum	8.499	3.770
	Total Toxic Organics (TTO)*	0.96	-
	Oil & Grease**	13.91	13.91
	Total Suspended Solids	20.865	16.692
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-15 (Continued)

PSNS FOR THE ROLLING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.387	0.154
119	Chromium*	0.72	0.29
120	Copper	2.474	1.179
121	Cyanide*	0.39	0.16
122	Lead	0.541	0.251
124	Nickel	1.063	0.715
125	Selenium	1.585	0.715
128	Zinc*	1.97	0.81
	Aluminum	11.810	5.238
	Total Toxic Organics (TTO)*	1.34	-
	Oil & Grease**	19.33	19.33
	Total Suspended Solids	28.995	23.196
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-16

PSNS FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Rolling With Emulsions - Core Waste Streams

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum rolled with emulsions		
118 Cadmium	0.026	0.010
119 Chromium*	0.048	0.020
120 Copper	0.166	0.079
121 Cyanide*	0.026	0.011
122 Lead	0.037	0.017
124 Nickel	0.071	0.048
125 Selenium	0.106	0.048
128 Zinc*	0.133	0.055
Aluminum	0.793	0.352
Total Toxic Organics (TTO)*	0.090	-
Oil & Grease**	1.30	1.30
Total Suspended Solids	1.947	1.558
pH	Within the range of 7.0 to 10.0 at all times.	

Direct Chill Casting - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by direct chill methods		
118 Cadmium	0.266	0.106
119 Chromium*	0.49	0.20
120 Copper	1.701	0.811
121 Cyanide*	0.27	0.11
122 Lead	0.372	0.173
124 Nickel	0.731	0.492
125 Selenium	1.090	0.492
128 Zinc*	1.36	0.56
Aluminum	8.120	3.602
Total Toxic Organics (TTO)*	0.92	-
Oil & Grease**	13.29	13.29
Total Suspended Solids	19.935	15.948
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-16 (Continued)

PSNS FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	0.407	0.163
119	Chromium*	0.76	0.31
120	Copper	2.607	1.243
121	Cyanide*	0.41	0.17
122	Lead	0.571	0.265
124	Nickel	1.120	0.754
125	Selenium	1.670	0.754
128	Zinc*	2.08	0.86
	Aluminum	12.446	5.520
	Total Toxic Organics (TTO)*	1.41	-
	Oil & Grease**	20.37	20.37
	Total Suspended Solids	30.555	24.444
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.036	0.014
119	Chromium*	0.067	0.027
120	Copper	0.229	0.109
121	Cyanide*	0.036	0.015
122	Lead	0.050	0.023
124	Nickel	0.099	0.066
125	Selenium	0.147	0.066
128	Zinc*	0.183	0.075
	Aluminum	1.094	0.485
	Total Toxic Organics (TTO)*	0.124	-
	Oil & Grease**	1.79	1.79
	Total Suspended Solids	2.685	2.148
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-16 (Continued)

PSNS FOR THE ROLLING WITH EMULSIONS SUBCATEGORY

Cleaning or Etching - Rinse

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.278	0.111
119	Chromium*	0.52	0.21
120	Copper	1.781	0.849
121	Cyanide*	0.28	0.11
122	Lead	0.390	0.181
124	Nickel	0.765	0.515
125	Selenium	1.140	0.515
128	Zinc*	1.42	0.59
	Aluminum	8.499	3.770
	Total Toxic Organics (TTO)*	0.96	-
	Oil & Grease**	13.91	13.91
	Total Suspended Solids	20.865	16.692
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.387	0.154
119	Chromium*	0.72	0.29
120	Copper	2.474	1.179
121	Cyanide*	0.39	0.16
122	Lead	0.541	0.251
124	Nickel	1.063	0.715
125	Selenium	1.585	0.715
128	Zinc*	1.97	0.81
	Aluminum	11.810	5.238
	Total Toxic Organics (TTO)*	1.34	-
	Oil & Grease**	19.33	19.33
	Total Suspended Solids	28.995	23.196
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-17

PSNS FOR THE EXTRUSION SUBCATEGORY

Extrusion - Core Waste Streams

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum extruded		
118	Cadmium	0.068	0.027
119	Chromium*	0.13	0.05
120	Copper	0.435	0.208
121	Cyanide*	0.07	0.03
122	Lead	0.095	0.044
124	Nickel	0.187	0.126
125	Selenium	0.279	0.126
128	Zinc*	0.35	0.15
	Aluminum	2.078	0.922
	Total Toxic Organics (TTO)*	0.24	-
	Oil & Grease**	3.40	3.40
	Total Suspended Solids	5.102	4.081
	pH	Within the range of 7.0 to 10.0 at all times.	

Direct Chill Casting - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cast by direct chill methods		
118	Cadmium	0.266	0.106
119	Chromium*	0.49	0.20
120	Copper	1.701	0.811
121	Cyanide*	0.27	0.11
122	Lead	0.372	0.173
124	Nickel	0.731	0.492
125	Selenium	1.090	0.492
128	Zinc*	1.36	0.56
	Aluminum	8.120	3.602
	Total Toxic Organics (TTO)*	0.92	-
	Oil & Grease**	13.29	13.29
	Total Suspended Solids	19.935	15.948
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-17 (Continued)

PSNS FOR THE EXTRUSION SUBCATEGORY

Solution and Press Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	0.407	0.163
119	Chromium*	0.76	0.31
120	Copper	2.607	1.243
121	Cyanide*	0.41	0.17
122	Lead	0.571	0.265
124	Nickel	1.120	0.754
125	Selenium	1.670	0.754
128	Zinc*	2.08	0.86
	Aluminum	12.446	5.520
	Total Toxic Organics (TTO)*	1.41	-
	Oil & Grease**	20.37	20.37
	Total Suspended Solids	30.555	24.444
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.036	0.014
119	Chromium*	0.067	0.027
120	Copper	0.229	0.109
121	Cyanide*	0.036	0.015
122	Lead	0.050	0.023
124	Nickel	0.099	0.066
125	Selenium	0.147	0.066
128	Zinc*	0.183	0.075
	Aluminum	1.094	0.485
	Total Toxic Organics (TTO)*	0.124	-
	Oil & Grease**	1.79	1.79
	Total Suspended Solids	2.685	2.148
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-17 (Continued)

PSNS FOR THE EXTRUSION SUBCATEGORY

Cleaning or Etching - Rinse

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.278	0.111
119	Chromium*	0.52	0.21
120	Copper	1.781	0.849
121	Cyanide*	0.28	0.11
122	Lead	0.390	0.181
124	Nickel	0.765	0.515
125	Selenium	1.140	0.515
128	Zinc*	1.42	0.59
	Aluminum	8.499	3.770
	Total Toxic Organics (TTO)*	0.96	-
	Oil & Grease**	13.91	13.91
	Total Suspended Solids	20.865	16.692
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.387	0.154
119	Chromium*	0.72	0.29
120	Copper	2.474	1.179
121	Cyanide*	0.39	0.16
122	Lead	0.541	0.251
124	Nickel	1.063	0.715
125	Selenium	1.585	0.715
128	Zinc*	1.97	0.81
	Aluminum	11.810	5.238
	Total Toxic Organics (TTO)*	1.34	-
	Oil & Grease**	19.33	19.33
	Total Suspended Solids	28.995	23.196
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-17 (Continued)

PSNS FOR THE EXTRUSION SUBCATEGORY

Degassing - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum degassed		
118	Cadmium	0.00	0.00
119	Chromium*	0.00	0.00
120	Copper	0.00	0.00
121	Cyanide*	0.00	0.00
122	Lead	0.00	0.00
124	Nickel	0.00	0.00
125	Selenium	0.00	0.00
128	Zinc*	0.00	0.00
	Aluminum	0.00	0.00
	Total Toxic Organics (TTO)*	0.00	-
	Oil & Grease**	0.00	0.00
	Total Suspended Solids	0.00	0.00
	pH	Within the range of 7.0 to 10.0 at all times.	

Extrusion Press Hydraulic Fluid Leakage

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum extruded		
118	Cadmium	0.060	0.024
119	Chromium*	0.11	0.05
120	Copper	0.381	0.182
121	Cyanide*	0.060	0.03
122	Lead	0.084	0.039
124	Nickel	0.164	0.110
125	Selenium	0.244	0.110
128	Zinc*	0.31	0.13
	Aluminum	1.821	0.808
	Total Toxic Organics (TTO)*	0.21	-
	Oil & Grease**	2.98	2.98
	Total Suspended Solids	4.470	3.576
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-18

PSNS FOR THE FORGING SUBCATEGORY

Forging - Core Waste Streams

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum forged		
118	Cadmium	0.010	0.004
119	Chromium*	0.019	0.008
120	Copper	0.064	0.030
121	Cyanide*	0.010	0.004
122	Lead	0.014	0.007
124	Nickel	0.027	0.018
125	Selenium	0.041	0.018
128	Zinc*	0.051	0.021
	Aluminum	0.304	0.135
	Total Toxic Organics (TTO)*	0.035	-
	Oil & Grease**	0.50	0.50
	Total Suspended Solids	0.747	0.598
	pH	Within the range of 7.0 to 10.0 at all times.	

Forging - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum forged		
118	Cadmium	0.019	0.008
119	Chromium*	0.035	0.014
120	Copper	0.121	0.058
121	Cyanide*	0.019	0.008
122	Lead	0.027	0.013
124	Nickel	0.052	0.035
125	Selenium	0.077	0.035
128	Zinc*	0.096	0.040
	Aluminum	0.576	0.256
	Total Toxic Organics (TTO)*	0.065	-
	Oil & Grease**	0.95	0.95
	Total Suspended Solids	1.415	1.132
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-18 (Continued)

PSNS FOR THE FORGING SUBCATEGORY

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum quenched		
118	Cadmium	0.407	0.163
119	Chromium*	0.76	0.31
120	Copper	2.607	1.243
121	Cyanide*	0.41	0.16
122	Lead	0.571	0.265
124	Nickel	1.120	0.754
125	Selenium	1.670	0.754
128	Zinc*	2.08	0.86
	Aluminum	12.446	5.520
	Total Toxic Organics (TTO)*	1.41	-
	Oil & Grease**	20.37	20.37
	Total Suspended Solids	30.555	24.444
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Bath

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.036	0.014
119	Chromium*	0.067	0.027
120	Copper	0.229	0.109
121	Cyanide*	0.036	0.015
122	Lead	0.050	0.023
124	Nickel	0.099	0.066
125	Selenium	0.147	0.066
128	Zinc*	0.183	0.075
	Aluminum	1.094	0.485
	Total Toxic Organics (TTO)*	0.124	-
	Oil & Grease**	1.79	1.79
	Total Suspended Solids	2.685	2.148
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-18 (Continued)

PSNS FOR THE FORGING SUBCATEGORY

Cleaning or Etching - Rinse

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.278	0.111
119	Chromium*	0.52	0.21
120	Copper	1.781	0.849
121	Cyanide*	0.28	0.11
122	Lead	0.390	0.181
124	Nickel	0.765	0.515
125	Selenium	1.140	0.515
128	Zinc*	1.42	0.59
	Aluminum	8.499	3.770
	Total Toxic Organics (TTO)*	0.96	-
	Oil & Grease**	13.91	13.91
	Total Suspended Solids	20.865	16.692
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Scrubber Liquor

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.387	0.154
119	Chromium*	0.72	0.29
120	Copper	2.474	1.179
121	Cyanide*	0.39	0.16
122	Lead	0.541	0.251
124	Nickel	1.063	0.715
125	Selenium	1.585	0.715
128	Zinc*	1.97	0.812
	Aluminum	11.810	5.238
	Total Toxic Organics (TTO)*	1.34	-
	Oil & Grease**	19.33	19.33
	Total Suspended Solids	28.995	23.196
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-19

PSNS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Drawing With Neat Oils - Core Waste Streams

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum drawn with neat oils		
118 Cadmium	0.010	0.004
119 Chromium*	0.019	0.008
120 Copper	0.064	0.030
121 Cyanide*	0.010	0.004
122 Lead	0.014	0.007
124 Nickel	0.027	0.018
125 Selenium	0.041	0.018
128 Zinc*	0.051	0.021
Aluminum	0.304	0.135
Total Toxic Organics (TTO)*	0.035	-
Oil & Grease**	0.50	0.50
Total Suspended Solids	0.747	0.598
pH	Within the range of 7.0 to 10.0 at all times.	

Continuous Rod Casting - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.039	0.016
119 Chromium*	0.072	0.029
120 Copper	0.248	0.118
121 Cyanide*	0.039	0.016
122 Lead	0.054	0.025
124 Nickel	0.107	0.072
125 Selenium	0.159	0.072
128 Zinc*	0.198	0.082
Aluminum	1.185	0.526
Total Toxic Organics (TTO)*	0.134	-
Oil & Grease**	1.94	1.94
Total Suspended Solids	2.909	2.327
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-19 (Continued)

PSNS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Continuous Rod Casting - Spent Lubricant

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.00039	0.00016
119 Chromium*	0.0007	0.0003
120 Copper	0.0025	0.0012
121 Cyanide*	0.0004	0.0002
122 Lead	0.00055	0.00026
124 Nickel	0.0011	0.00073
125 Selenium	0.0016	0.00073
128 Zinc*	0.0020	0.0008
Aluminum	0.012	0.0053
Total Toxic Organics (TTO)*	0.0014	-
Oil & Grease**	0.020	0.020
Total Suspended Solids	0.029	0.024
pH	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched		
118 Cadmium	0.407	0.163
119 Chromium*	0.76	0.306
120 Copper	2.607	1.243
121 Cyanide*	0.41	0.163
122 Lead	0.571	0.265
124 Nickel	1.120	0.754
125 Selenium	1.670	0.754
128 Zinc*	2.08	0.856
Aluminum	12.446	5.520
Total Toxic Organics (TTO)*	1.41	-
Oil & Grease**	20.37	20.37
Total Suspended Solids	30.555	24.444
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-19 (Continued)

PSNS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Bath

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched	
118 Cadmium	0.036	0.014
119 Chromium*	0.067	0.027
120 Copper	0.229	0.109
121 Cyanide*	0.036	0.015
122 Lead	0.050	0.023
124 Nickel	0.099	0.066
125 Selenium	0.147	0.066
128 Zinc*	0.183	0.075
Aluminum	1.094	0.485
Total Toxic Organics (TTO)*	0.124	-
Oil & Grease**	1.79	1.79
Total Suspended Solids	2.685	2.148
pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched	
118 Cadmium	0.278	0.111
119 Chromium*	0.52	0.21
120 Copper	1.781	0.849
121 Cyanide*	0.28	0.11
122 Lead	0.390	0.181
124 Nickel	0.765	0.515
125 Selenium	1.140	0.515
128 Zinc*	1.42	0.59
Aluminum	8.499	3.770
Total Toxic Organics (TTO)*	0.96	-
Oil & Grease**	13.91	13.91
Total Suspended Solids	20.865	16.692
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-19 (Continued)

PSNS FOR THE DRAWING WITH NEAT OILS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.387	0.154
119	Chromium*	0.72	0.29
120	Copper	2.474	1.179
121	Cyanide*	0.39	0.16
122	Lead	0.541	0.251
124	Nickel	1.063	0.715
125	Selenium	1.585	0.715
128	Zinc*	1.97	0.812
	Aluminum	11.810	5.238
	Total Toxic Organics (TTO)*	1.34	-
	Oil & Grease**	19.33	19.33
	Total Suspended Solids	28.995	23.196
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-20

PSNS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Drawing With Emulsions or Soaps - Core Waste Streams

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum drawn with emulsions or soaps		
118 Cadmium	0.093	0.037
119 Chromium*	0.173	0.070
120 Copper	0.597	0.284
121 Cyanide*	0.094	0.038
122 Lead	0.131	0.061
124 Nickel	0.257	0.173
125 Selenium	0.382	0.173
128 Zinc*	0.48	0.196
Aluminum	2.849	1.264
Total Toxic Organics (TTO)*	0.32	-
Oil & Grease**	4.67	4.67
Total Suspended Solids	6.995	5.596
pH	Within the range of 7.0 to 10.0 at all times.	

Continuous Rod Casting - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.039	0.016
119 Chromium*	0.072	0.029
120 Copper	0.248	0.118
121 Cyanide*	0.039	0.016
122 Lead	0.054	0.025
124 Nickel	0.107	0.072
125 Selenium	0.159	0.072
128 Zinc*	0.198	0.082
Aluminum	1.185	0.526
Total Toxic Organics (TTO)*	0.134	-
Oil & Grease**	1.94	1.94
Total Suspended Solids	2.909	2.327
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-20 (Continued)

PSNS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Continuous Rod Casting - Spent Lubricant

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum cast by continuous methods		
118 Cadmium	0.00039	0.00016
119 Chromium*	0.0008	0.0003
120 Copper	0.0025	0.0012
121 Cyanide*	0.0004	0.0002
122 Lead	0.00055	0.00026
124 Nickel	0.0011	0.00073
125 Selenium	0.0016	0.00073
128 Zinc*	0.0020	0.0008
Aluminum	0.012	0.0053
Total Toxic Organics (TTO)*	0.0014	-
Oil & Grease**	0.020	0.020
Total Suspended Solids	0.029	0.024
pH	Within the range of 7.0 to 10.0 at all times.	

Solution Heat Treatment - Contact Cooling Water

Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
mg/kg (lb/million lbs) of aluminum quenched		
118 Cadmium	0.407	0.163
119 Chromium*	0.76	0.306
120 Copper	2.607	1.243
121 Cyanide*	0.41	0.163
122 Lead	0.571	0.265
124 Nickel	1.120	0.754
125 Selenium	1.670	0.754
128 Zinc*	2.08	0.856
Aluminum	12.446	5.520
Total Toxic Organics (TTO)*	1.41	-
Oil & Grease**	20.37	20.37
Total Suspended Solids	30.555	24.444
pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-20 (Continued)

PSNS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Cleaning or Etching - Bath

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.036	0.014
119	Chromium*	0.067	0.027
120	Copper	0.229	0.109
121	Cyanide*	0.036	0.015
122	Lead	0.050	0.023
124	Nickel	0.099	0.066
125	Selenium	0.147	0.066
128	Zinc*	0.183	0.075
	Aluminum	1.094	0.485
	Total Toxic Organics (TTO)*	0.124	-
	Oil & Grease**	1.79	1.79
	Total Suspended Solids	2.685	2.148
	pH	Within the range of 7.0 to 10.0 at all times.	

Cleaning or Etching - Rinse

	Pollutant or Pollutant Property	Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.278	0.111
119	Chromium*	0.52	0.21
120	Copper	1.781	0.849
121	Cyanide*	0.28	0.11
122	Lead	0.390	0.181
124	Nickel	0.765	0.515
125	Selenium	1.140	0.515
128	Zinc*	1.42	0.59
	Aluminum	8.499	3.770
	Total Toxic Organics (TTO)*	0.96	-
	Oil & Grease**	13.91	13.91
	Total Suspended Solids	20.865	16.692
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

Table XII-20 (Continued)

PSNS FOR THE DRAWING WITH EMULSIONS OR SOAPS SUBCATEGORY

Cleaning or Etching - Scrubber Liquor

Pollutant or Pollutant Property		Maximum for Any One Day	Maximum for Monthly Average
	mg/kg (lb/million lbs) of aluminum cleaned or etched		
118	Cadmium	0.387	0.154
119	Chromium*	0.715	0.290
120	Copper	2.474	1.179
121	Cyanide*	0.387	0.155
122	Lead	0.541	0.251
124	Nickel	1.063	0.715
125	Selenium	1.585	0.715
128	Zinc*	1.97	0.812
	Aluminum	11.810	5.238
	Total Toxic Organics (TTO)*	1.34	-
	Oil & Grease**	19.33	19.33
	Total Suspended Solids	28.995	23.196
	pH	Within the range of 7.0 to 10.0 at all times.	

*Regulated pollutants.

**Alternate monitoring limit - oil and grease may be substituted for TTO.

SECTION XIII

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY

The 1977 amendments to the Clean Water Act added Section 301(b)(2)(E), establishing "best conventional pollutant control technology" (BCT) for discharge of conventional pollutants from existing industrial point sources. Biological oxygen-demanding form, oil and grease (O&G), and pH are considered by EPA to be conventional pollutants (see 44 FR 50732).

BCT is not an additional limitation but replaces BAT for the control of conventional pollutants. In addition to other factors specified in Section 304(b)(4)(B), the Act requires that BCT limitations be assessed in light of a two part "cost-reasonableness" test (American Paper Institute v. EPA, 660 F.2d 954 (4th Cir. 1981)). The first test compares the cost for private industry to reduce its conventional pollutants with the costs to publicly owned treatment works for similar levels of reduction in their discharge of these pollutants. The second test examines the cost-effectiveness of additional industrial treatment beyond BPT. EPA must find that limitations are "reasonable" under both tests before establishing them as BCT. In no case may BCT be less stringent than BPT.

EPA published its methodology for carrying out the BCT analysis on August 29, 1979 (44 FR 50732). In the case mentioned above, the Court of Appeals ordered EPA to correct data errors underlying EPA's calculation of the first test, and to apply the second cost test. (EPA argued that a second cost test was not required.) On October 29, 1982, the Agency proposed a revised BCT methodology. EPA is deferring proposal of BCT limitations for the aluminum forming category until the revised methodology can be applied to the technologies available for the control of conventional pollutants in the aluminum forming category.

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SECTION XIV

ACKNOWLEDGEMENT

The initial drafts of this document were prepared by Sverdrup & Parcel and Associates under Contract No. 68-01-4408. The document has been checked and revised at the specific direction of EPA personnel by Radian Corporation under Contract No. 68-01-6529.

The initial field sampling programs were conducted under the leadership of Garry Aronberg of Sverdrup & Parcel. Preparation and writing of the initial drafts of this document were accomplished by Donald Washington, Garry Aronberg, Claudia O'Leary, Anthony Tawa, Charles Amelotti, James Coll, and Jeff Carlton of Sverdrup & Parcel. Subsequent revisions to this document and preparation in its final form were performed under the leadership of James Sherman, Program Manager, Mark Hereth, Project Director, Michael Zapkin and Heidi Welner, Aluminum Forming Task Leaders of Radian Corporation. Field sampling programs after proposal were conducted under the leadership of Nancy Stein and Mark Hereth. Ronald Dickson, Marc Papai, Robert Curtis, John Collins, Thomas Grome, Karen Christensen, Lori Stoll, and Laurie Morgan contributed in specific assignments in the final preparation of this document.

The project was conducted by the Environmental Protection Agency, Ernst P. Hall, Chief, Metals and Machinery Branch. The technical project officer is Janet K. Goodwin; previous technical project officers include Carl Kassebaum, and Stewart Colton. The project's legal advisor is Jill Weller; previous legal advisors who contributed to this project include Ellen Maldonado, Mike Dworkin, Richard Shechter, and Daniel Glanz. The economic project officer is Ellen Warhit; previous economic project officers include Joseph Yance, John Ataman, Emily Hartnell, and William Webster. Statistical and environmental evaluations were performed by Monitoring and Data Support Division. Statistical evaluations were performed by Henry Kahn and Barnes Johnson. Environmental evaluations were performed by Eleanor Zimmerman, Richard Healy, and Richard Silver.

The cooperation of the Aluminum Association, Inc., their technical committee, and the individual aluminum forming companies whose plants were sampled and who submitted detailed information in response to questionnaires, letters, and telephone contacts is gratefully appreciated.

Acknowledgement and appreciation is also given to the secretarial staff of Radian Corporation (Nancy Reid, Daphne Phillips, Sandra Moore, and Pamela Anshey).

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A special commendation is given to the word processing staff of the Effluent Guidelines Division (Pearl Smith, Carol Swann, and Glenda Clarke) for their tireless efforts preparing the numerous drafts, necessary revisions, and preparation of this effluent guidelines document.

SECTION XV

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SECTION XVI

GLOSSARY

This section is an alphabetical listing of technical terms (with definitions) used in this document which may not be familiar to the reader.

4-AAP Colorimetric Method

An analytical method for total phenols and total phenolic compounds that involves reaction with the color developing agent 4-aminoantipyrine.

Acid Dip

Using any acid for the purpose of cleaning any material. Some methods of acid cleaning are pickling and oxidizing.

Acidity

The quantitative capacity of aqueous solutions to react with hydroxyl ions. Measured by titration with a standard solution of a base to a specified end point. Usually expressed as milligrams per liter of calcium carbonate.

The Act

The Federal Water Pollution Control Act Amendments of 1972 as amended by the Clean Water Act of 1977 (PL 92-500).

Aging

A change in the properties of certain metals and alloys that occurs at ambient or moderately elevated temperatures after hot working or heat treatment (quench aging in ferrous alloys, natural or artificial aging in ferrous and nonferrous alloys) or after a cold working operation (strain aging). The change in properties is often due to a phase change (precipitation), but never involves a change in chemical composition of the metal or alloy.

Alkaline Cleaning

A proces where dirt, mineral and animal fats, and oils are removed from the metal surface by exposure to solutions at high temperatures containing alkaline compounds, such as caustic soda, soda ash, alkaline silicates, and alkaline phosphates.

Alkalinity

The capacity of water to neutralize acids, a property imparted by the water's content of carbonates, bicarbonates, hydroxides, and occasionally borates, silicates, and phosphates. It is measured by titration with a standardized acid to a specified end point, and is usually reported in milligrams per liter of calcium carbonate.

Aluminum Forming

A set of manufacturing operations in which aluminum and aluminum alloys are made into semifinished products by hot or cold working.

Amortization

The allocation of a cost or account according to a specified schedule, based on the principal, interest and period of cost allocation.

Analytical Quantification Level

The minimum concentration at which quantification of a specified pollutant can be reliably measured.

Ancillary Operations

A manufacturing operation that has a large flow, discharges significant amounts of pollutants, and may not be present at every plant in a subcategory, but when present it is an integral part of the aluminum forming process.

Annealing

A generic term describing a metals treatment process that is used primarily to soften metallic materials, but also to simultaneously produce desired changes in other properties or in microstructure. The purpose of such changes may be, but is not confined to, improvement of machinability, facilitation of cold work, improvement of mechanical or electrical properties, or increase in stability of dimensions. Annealing consists of heating and cooling the metal at varying rates to achieve the desired properties.

Backwashing

The operation of cleaning a filter or column by reversing the flow of liquid through it and washing out matter previously trapped.

Batch Treatment

A waste treatment method where wastewater is collected over a period of time and then treated prior to discharge. Treatment is not continuous, but collection may be continuous.

Bench-Scale Pilot Studies

Experiments providing data concerning the treatability of a wastewater stream or the efficiency of a treatment process conducted using laboratory-size equipment.

Best Available Demonstrated Technology (BADT)

Treatment technology upon new source performance standards as defined by Section 306 of the Act.

Best Available Technology Economically Achievable (BAT)

Level of technology applicable to toxic and nonconventional pollutants on which effluent limitations are established. These limitations are to be achieved by July 1, 1984 by industrial discharges to surface waters as defined by Section 304(b)(2)(B) of the Act.

Best Conventional Pollutant Control Technology (BCT)

Level of technology applicable to conventional pollutant effluent limitations to be achieved by July 1, 1984 for industrial discharges to surface waters as defined in Section 304(b)(4)(E) of the act.

Best Management Practices (BMP)

Regulations intended to control the release of toxic and hazardous pollutants from plant runoff, spillage, leaks, solid waste disposal, and drainage from raw material storage as discussed by Section 304(3) of the Act.

Best Practicable Control Technology Currently Available (BPT)

Level of technology applicable to effluent limitations to have been achieved by July 1, 1977 (originally) for industrial discharges to surface waters as defined by Section 301(b)(1) of the Act.

Billet

A long slender cast product used as raw material in subsequent forming operations.

Biochemical Oxygen Demand (BOD)

The quantity of oxygen used in the biochemical oxidation of organic matter under specified conditions for a specified time.

Blowdown

The minimum discharge of circulating water for the purpose of discharging dissolved solids or other contaminants contained in the water, the further buildup of which would cause concentration in amounts exceeding limits established by best engineering practice.

Catalyst

An agent that (1) reduces the energy required for activating a chemical reaction and (2) is not consumed by that reaction.

Chelation

The formation of coordinate covalent bonds between a central metal ion and a liquid that contains two or more sites for combination with the metal ion.

Chemical Finishing

Producing a desired finish on the surface of a metallic product by immersing the workpiece in a chemical bath.

Chemical Oxygen Demand (COD)

A measure of the oxygen-consuming capacity of the organic and inorganic matter present in the water or wastewater.

Cleaning (see etching)

Cold Rolling

An operation that produces aluminum sheet with a thickness between 6.25 cm and 0.015 cm (0.249 to 0.006 inches) by passing the aluminum through a set of rolls. The process is an exothermic process and causes strain-hardening of the product.

Colloid

Suspended solids whose diameter may vary between less than one micron and fifteen microns.

Composite Samples

A series of samples collected over a period of time but combined into a single sample for analysis. The individual samples can be taken after a specified amount of time has passed (time composited), or after a specified volume of water has passed the sampling point (flow composited). The sample can be automatically collected and composited by a sampler or can be manually collected and combined.

Consent Decree (Settlement Agreement)

Agreement between EPA and various environmental groups, as instituted by the United States District Court for the District of Columbia, directing EPA to study and promulgate regulations for the toxic pollutants (NRDC, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified March 9, 1979, 12 ERC 1833, 1841).

Contact Water

Any wastewater which contacts the aluminum workpieces or the raw materials used in forming aluminum.

Continuous Casting

A casting process that produces sheet, rod, or other long shapes by solidifying the metal while it is being poured through an open-ended mold using little or no contact cooling water. No restrictions are placed on the length of the product and it is not necessary to stop the process to remove the cast product. Continuous casting of rod and sheet generates spent lubricants and rod casting also generates contact cooling water.

Continuous Treatment

Treatment of waste streams operating without interruption as opposed to batch treatment. Sometimes referred to as flowthrough treatment.

Contractor Removal

Disposal of oils, spent solutions, or sludge by a commercial firm.

Conventional Pollutants

Constitutents of wastewater as determined by Section 304(a)(4) of the Act, including but not limited to pollutants classified as biological-oxygen-demanding, oil and grease, suspended solids, fecal coliforms, and pH.

Conversion Coating

A coating produced by chemical or electrochemical treatment of a metallic surface that gives a surface layer containing a compound of the metal. For example, chromate coatings on zinc and cadmium, oxide coatings on steel.

Cooling Tower

A hollow, vertical structure with internal baffles designed to break up falling water so that it is cooled by upward-flowing air and the evaporation of water.

Core Stream

A waste stream generated by operations that always occur within a particular subcategory.

Countercurrent Cascade Rinsing

A staged process that employs recycled, often untreated water as a rinsing medium to clean metal products. Water flow is opposite to product flow such that the most contaminated water encounters incoming product first.

Data Collection Portfolio (dcp)

The questionnaire used in the survey of the aluminum forming industry.

Degassing

The removal of dissolved hydrogen from the molten aluminum prior to casting. Chemicals are added and gases are bubbled through the molten aluminum. Sometimes a wet scrubber is used to reduce opacity created by excess chlorine gas. This process also helps to remove oxides and impurities from the melt.

Deoxidizing

The removal of any oxide film (such as aluminum oxide) from a metal.

Desmutting

A process that removes a residual silt (smut) by immersing the product in an acid solution, usually nitric acid.

Direct Chill Casting

A method of casting where the molten aluminum is poured into a water-cooled mold. Contact cooling water is sprayed onto the aluminum as it is dropped into the mold, and the aluminum ingot falls into a water bath at the end of the casting process. The vertical distance of the drop limits the length of the ingot. This process is also known as semi-continuous casting.

Direct Discharger

Any point source that discharges to a surface water.

Dragout

The solution that adheres to the objects removed from a bath or rinse, more precisely defined as that solution which is carried past the edge of the tank.

Drawing

Pulling the metal through a die or succession of dies to reduce the metal's diameter or alter its shape. There are two aluminum forming subcategories based on the drawing process. In the drawing with neat oils subcategory, the drawing process uses a pure or neat oil as a lubricant. In the drawing with emulsions or soaps subcategory, the drawing process uses an emulsion or soap solution as a lubricant.

Drying Beds

Areas for dewatering of sludge by evaporation and seepage.

Effluent

Discharge from a point source.

Effluent Limitation

Any standard (including schedules of compliance) established by a state or EPA on quantities, rates, and concentrations of chemical, physical, biological, and other constituents that are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean.

Electrochemical Finishing

Producing a desired finish on the surface of a metallic product by immersing the workpiece in an electrolyte bath through which direct current is passed.

Electroplating

The production of a thin coating of one metal on another by electrodeposition.

Electrostatic Precipitator (ESP)

A gas cleaning device that induces an electrical charge on a solid particle which is then attracted to an oppositely charged collector plate. The collector plates are intermittently vibrated to discharge the collected dust to a hopper.

Emulsifying Agent

A material that increases the stability of a dispersion of one liquid in another.

Emulsions

Stable dispersions of two immiscible liquids. In the aluminum forming category this is usually an oil and water mixture.

End-of-Pipe Treatment

The reduction of pollutants by wastewater treatment prior to discharge or reuse.

Etching

A chemical solution bath and a rinse or a series of rinses designed to produce a desired surface finish on the work piece, either to remove surface imperfections, oxides or scratches or to provide surface roughness. This term includes air pollution control scrubbers which are sometimes used to control fumes from chemical solution baths. Conversion coating and anodizing when performed as an integral part of the aluminum forming operations are considered cleaning or etching operations. When conversion coating or anodizing are covered here they are not subject to regulation under the provisions of 40 CFR Parts 413 and 433, Electroplating and Metal Finishing.

Eutectic Temperature

The lowest temperature at which a solution (in this case, the solution is molten aluminum and various alloying materials) remains completely liquid.

Extrusion

A process in which high pressures are applied to a billet of aluminum, forcing the aluminum to flow through a die orifice. The extrusion subcategory is based on the extrusion process.

Finishing

The coating or polishing of a metal surface.

Fluxes

Substances added to molten metal to help remove impurities and prevent excessive oxidation, or promote the fusing of the metals.

Foil Rolling

A process which produces aluminum foil less than 0.006 inches thick. Foil is usually produced by cold rolling.

Forging

A process that exerts pressure on die or rolls surrounding aluminum stock which is usually heated, forcing the stock to take the shape of the dies. The forging subcategory is based on the forging process.

Gas Chromatography/Mass Spectroscopy (GC/MS)

Chemical analytical instrumentation used for quantitative organic analysis.

Grab Sample

A single sample of wastewater taken without regard to time or flow.

Heat Treatment

The application of heat of specified temperature and duration that changes the physical properties of the metal, such as strength, ductility, and malleability.

Homogenizing

Holding solidified aluminum at high temperature to eliminate or decrease chemical segregation by diffusion.

Hot Rolling

The process in which aluminum is heated to between 400°C and 495° C and passed through a set of rolls which reduces the thickness of the metal to a plate 6.3 mm (0.25 inches) thick or less. Hot rolling does not strain-harden the aluminum.

Indirect Discharger

A point source that introduces effluents into a publicly owned treatment works.

Inductively-Coupled Argon Plasma Spectrophotometer (ICAP)

A laboratory device used for the analysis of metals.

Ingot

A large, block-shaped casting produced by various methods. Ingots are intermediate products from which formed products are made.

In-Process Control Technology

Any procedure or equipment used to conserve chemicals and water throughout the production operations, resulting in a reduction of the wastewater volume to be discharged.

Neat Oil

A pure oil, usually a mineral oil, with no or few impurities added. In aluminum forming its use is mostly as a lubricant.

New Source Performance Standards (NSPS)

Effluent limitations for new industrial point sources as defined by Section 306 of the Act.

Nonconventional Pollutant

Parameters selected for use in performance standards that have not been previously designated as either conventional or toxic pollutants.

Non-Water Quality Environmental Impact

The ecological impact as a result of solid, air, or thermal pollution due to the application of various wastewater technologies to achieve the effluent guidelines limitations. Also associated with the non-water quality aspect is the energy impact of wastewater treatment.

NPDES Permits

Permits issued by EPA or an approved state program under the National Pollution Discharge Elimination System issued under Section 402 of the Act.

Off-Gases

Gases, vapors, and fumes produced as a result of an aluminum forming operation.

Off-Kilogram (Off-Pound)

The mass of aluminum or aluminum alloy removed from a forming or ancillary operation at the end of a process cycle for transfer to a different machine or process.

Oil and Grease (O&G)

Any material that is extracted by freon from an acidified sample and that is not volatilized during the analysis, such as hydrocarbons, fatty acids, soaps, fats, waxes, and oils.

pH

The pH is the negative logarithm of the hydrogen ion activity of a solution.

Pickling

The process of removing scale, oxide, or foreign matter from the surface of metal by immersing it in a bath containing a suitable chemical reagent that will attack the oxide or scale, but will not act appreciably upon the metal during the period of pickling. Frequently it is necessary to immerse the metal in a detergent solution or to degrease it before pickling.

Plate

A flat, extended, rigid body of aluminum having a thickness greater than or equal to 6.3 mm (0.25 inches).

Pollutant Parameters

Those constituents of wastewater determined to be detrimental and, therefore, requiring control.

Priority Pollutants

Those pollutants included in Table 2 of Committee Print number 95-30 of the "Committee on Public Works and Transportation of the House of Representatives," subject to the Act.

Process Water

Water used in a production process that contacts the product, raw materials, or reagents.

Production Normalizing Parameter (PNP)

The unit of production specified in the regulations used to determine the mass of pollution a production facility may discharge.

PSES

Pretreatment standards (effluent regulations) for existing sources under Section 307(b) of the Act.

PSNS

Pretreatment standards (effluent regulations) for new sources under Section 307(c) of the Act.

Publicly Owned Treatment Works (POTW)

A waste treatment facility that is owned by a state or municipality.

Recycle

Returning treated or untreated wastewater to the production process from which it originated for use as process water.

Reduction

A reaction in which there is a decrease in valence resulting from a gain in electrons.

Reuse

The use of treated or untreated process wastewater in a different production process.

Reverberatory Furnaces

Rectangular furnaces in which the fuel is burned above the metal and the heat reflects off the walls and into the metal.

Rinsing

A process in which water is used to wash etching and cleaning chemicals from the surface of metal.

Rod

An intermediate aluminum product having a solid, round cross section 9.5 mm (3/8 inches) or more in diameter.

Rolling

A forming process that reduces the thickness of a workpiece by passing it between a pair of lubricated steel rollers. There are two subcategories based on the rolling process. In the rolling with neat oils subcategory, pure or neat oils are used as lubricants for the rolling process. In the rolling with emulsions subcategory, emulsions are used as lubricants for the rolling process.

Scrubber Liquor

The untreated wastewater stream produced by wet scrubbers cleaning gases produced by aluminum forming operations.

Seal Baths

A bath used as the final surface finishing step performed in conjunction with anodizing. Seal baths usually consist of boiling deionized water or nickel acetate.

Seal Water

A water curtain used as a barrier between the annealing furnance atmosphere and the outside atmosphere.

Semi-Fabricated Products

Intermediate products that are the final product of one process and the raw material for a second process.

Stationary Casting

A process in which the molten aluminum is poured into molds and allowed to air-cool. It is often used to recycle in-house scrap.

Strain-Hardening (see work-hardening)

Subcategorization

The process of segmentation of an industry into groups of plants for which uniform effluent limitations can be established.

Surface Water

Any visible stream or body of water, natural or man-made. This does not include bodies of water whose sole purpose is wastewater retention or the removal of pollutants, such as holding ponds or lagoons.

Surfactants

Surface active chemicals that tend to lower the surface tension between liquids.

Swaging

A process in which a solid point is formed at the end of a tube, rod, or bar by the repeated blows of one or more pairs of opposing dies. It is often the initial step in the drawing process.

Total Dissolved Solids (TDS)

Organic and inorganic molecules and ions that are in true solution in the water or wastewater.

Total Organic Carbon (TOC)

A measure of the organic contaminants in a wastewater. The TOC analysis does not measure as much of the organics as the COD or BOD tests, but is much quicker than these tests.

Total Recycle

The complete reuse of a stream, with makeup water added for evaporation losses. There is no blowdown stream from a totally recycled flow and the process water is not periodically or continuously discharged.

Total Suspended Solids (TSS)

Solids in suspension in water, wastewater, or treated effluent. Also known as suspended solids.

Total Toxic Organics (TTO)

The sum of the masses or concentrations of each of the following toxic organic compounds which is found in the discharge at a concentration greater than 0.010 mg/l:

p-chloro-m-cresol
2-chlorophenol
2,4-dinitrotoluene
1,2-diphenylhydrazine
ethylbenzene
benzo(ghi)perylene
fluorene
phenanthrene
dibenzo(a,h)anthracene
indeno(1,2,3-c,d)pyrene

fluoranthene
isophorone
naphthalene
N-nitrosodiphenylamine
phenol
benzo(a)pyrene
3,4-benzofluoranthene
benzo(k)fluoranthene
chrysene
acenaphthylene
anthracene
dimethyl phthalate
di-n-butyl benzyl phthalate
bis(2-ethylhexyl) phthalate
pyrene
tetrachloroethylene
toluene
trichloroethylene
endosulfan sulfate
endrin
endrin aldehyde
PCB-1242, 1254, 1221
PCB-1232, 1248, 1260, 1016
acenaphthene
diethyl phthalate
di-n-octyl phthalate
buthy benzyl phthalate

Tubing Blank

A sample taken by passing one gallon of distilled water through a composite sampling device before initiation of actual wastewater sampling.

Volatile Substances

Materials that are readily vaporizable at relatively low temperatures.

Wastewater Discharge Factor

The ratio between water discharged from a production process and the mass of product of that production process. Recycle water is not included.

Water Use Factor

The total amount of contact water or oil entering a process divided by the amount of aluminum product produced by this process. The amount of water involved includes the recycle and makeup water.

Wet Scrubbers

Air pollution control devices used for removing particulates and fumes from air as the gas passes through the spray.

Wire

A slender strand of aluminum with a diameter less than 9.5 mm (3/8 inches).

Work-Hardening

An increase in hardness and strength and a loss of ductility that occurs in the workpiece as a result of passing through cold forming or cold working operations. Also known as strain-hardening.

Zero Discharger

Any industrial or municipal facility that does not discharge wastewater. 538 The fluid from these leaks is frequently combined with other wastewaters

*U.S. GOVERNMENT PRINTING OFFICE : 1984 O-421-545/11822